In Collaboration with
CALIBRATION LABORATORY
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Appendix

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	48.4Ω - 5.62jΩ
Return Loss	- 24.5dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	55.5Ω - 5.39jΩ
Return Loss	- 22.8dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	52.4Ω - 4.20jΩ
Return Loss	- 26.5dB

Antenna Parameters with Body TSL at 5250 MHz

Impedance, transformed to feed point	50.4Ω - 5.86jΩ
Return Loss	- 24.7dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	57.2Ω - 1.59jΩ
Return Loss	- 23.3dB

Antenna Parameters with Body TSL at 5750 MHz

Impedance, transformed to feed point	56.0Ω - 0.37jΩ
Return Loss	- 24.9dB

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General Antenna Parameters and Design

Electrical Delay (one direction)	1.310 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

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DASY5 Validation Report for Head TSL Date: 01.05.2017

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1151

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz,

Medium parameters used: f = 5250 MHz; σ = 4.636 mho/m; εr = 35.38; ρ = 1000 kg/m3, Medium parameters used: f = 5600 MHz; σ = 5.015 mho/m; εr = 35.41; ρ = 1000 kg/m3, Medium parameters used: f = 5750 MHz; σ = 5.173 mho/m; εr = 36.06; ρ = 1000 kg/m3,

Phantom section: Center Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7433; ConvF(5.13,5.13,5.13); Calibrated: 2016/9/26, ConvF(4.59,4.59,4.59); Calibrated: 2016/9/26, ConvF(4.66,4.66,4.66); Calibrated: 2016/9/26,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2016/2/2
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/3
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 71.52 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 32.1 W/kg
SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.25 W/kg
Maximum value of SAR (measured) = 18.3 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.03 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 34.2 W/kg
SAR(1 g) = 8.16 W/kg; SAR(10 g) = 2.32 W/kg
Maximum value of SAR (measured) = 19.9 W/kg

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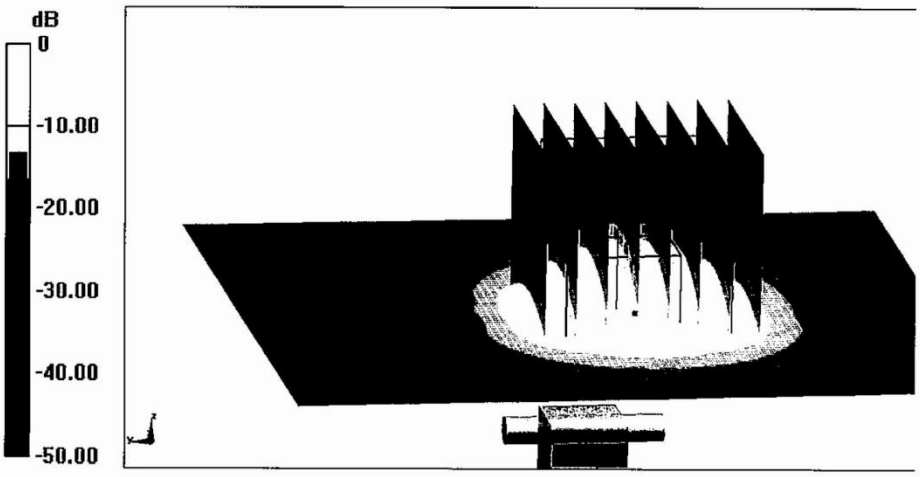
Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.85 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 35.0 W/kg
SAR(1 g) = 8.02 W/kg; SAR(10 g) = 2.26 W/kg
Maximum value of SAR (measured) = 19.7 W/kg



0 dB = 19.7 W/kg = 12.94 dBW/kg

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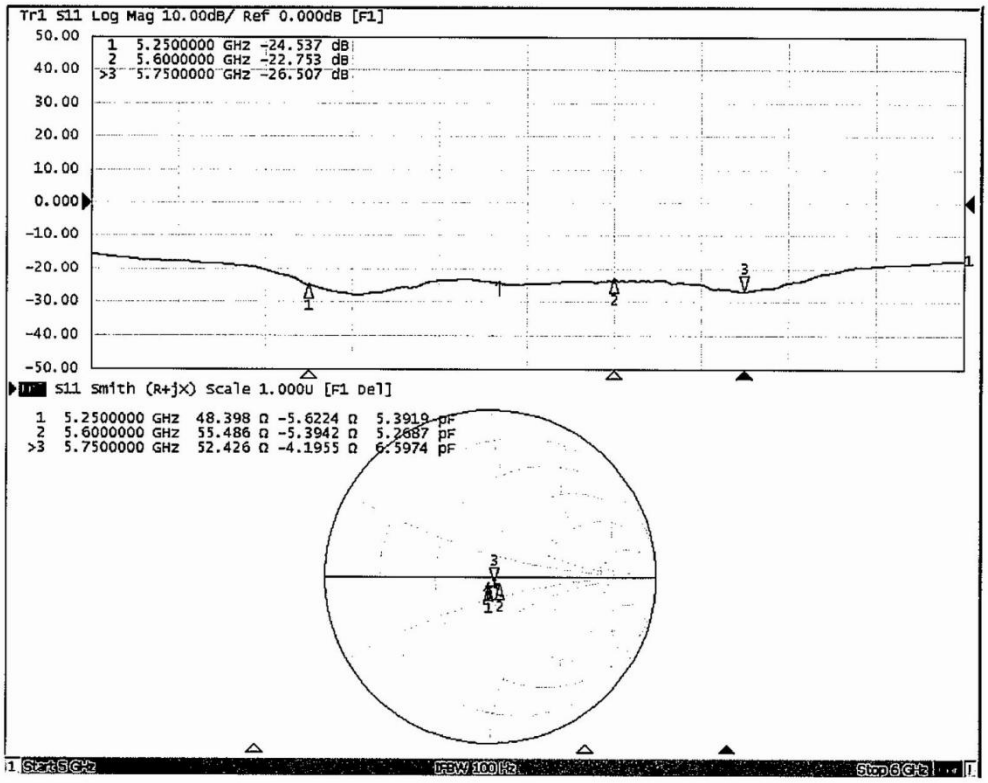
Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL Date: 01.04.2017

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1151

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz,

Medium parameters used: f = 5250 MHz; σ = 5.388 mho/m; εr = 47.81; ρ = 1000 kg/m3, Medium parameters used: f = 5600 MHz; σ = 5.704 mho/m; εr = 48.39; ρ = 1000 kg/m3, Medium parameters used: f = 5750 MHz; σ = 5.833 mho/m; εr = 48.61; ρ = 1000 kg/m3,

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7433; ConvF(4.68,4.68,4.68); Calibrated: 2016/9/26, ConvF(3.98,3.98,3.98); Calibrated: 2016/9/26, ConvF(4.35,4.35,4.35); Calibrated: 2016/9/26,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2016/2/2
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/3
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.69 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 28.5 W/kg
SAR(1 g) = 7.59 W/kg; SAR(10 g) = 2.15 W/kg
Maximum value of SAR (measured) = 17.7 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.67 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 33.8 W/kg
SAR(1 g) = 8.03 W/kg; SAR(10 g) = 2.23 W/kg
Maximum value of SAR (measured) = 19.8 W/kg

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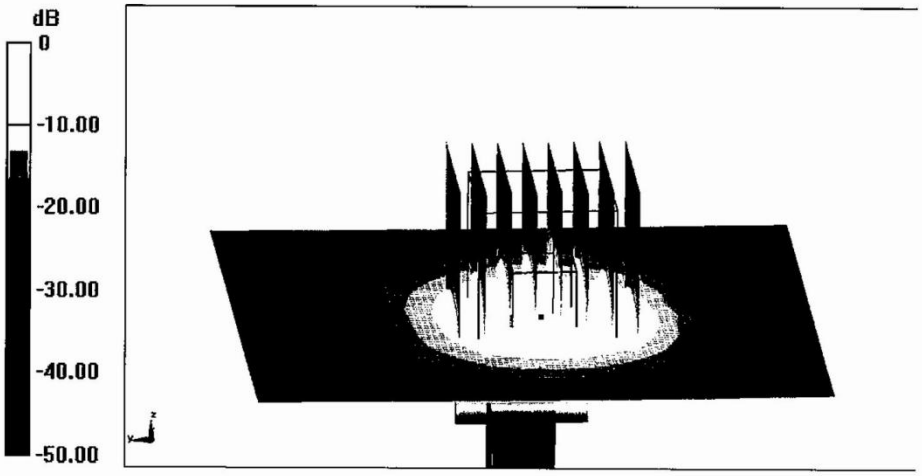
Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.76 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 30.0 W/kg
SAR(1 g) = 7.46 W/kg; SAR(10 g) = 2.1 W/kg
Maximum value of SAR (measured) = 17.5 W/kg



0 dB = 17.5 W/kg = 12.43 dBW/kg

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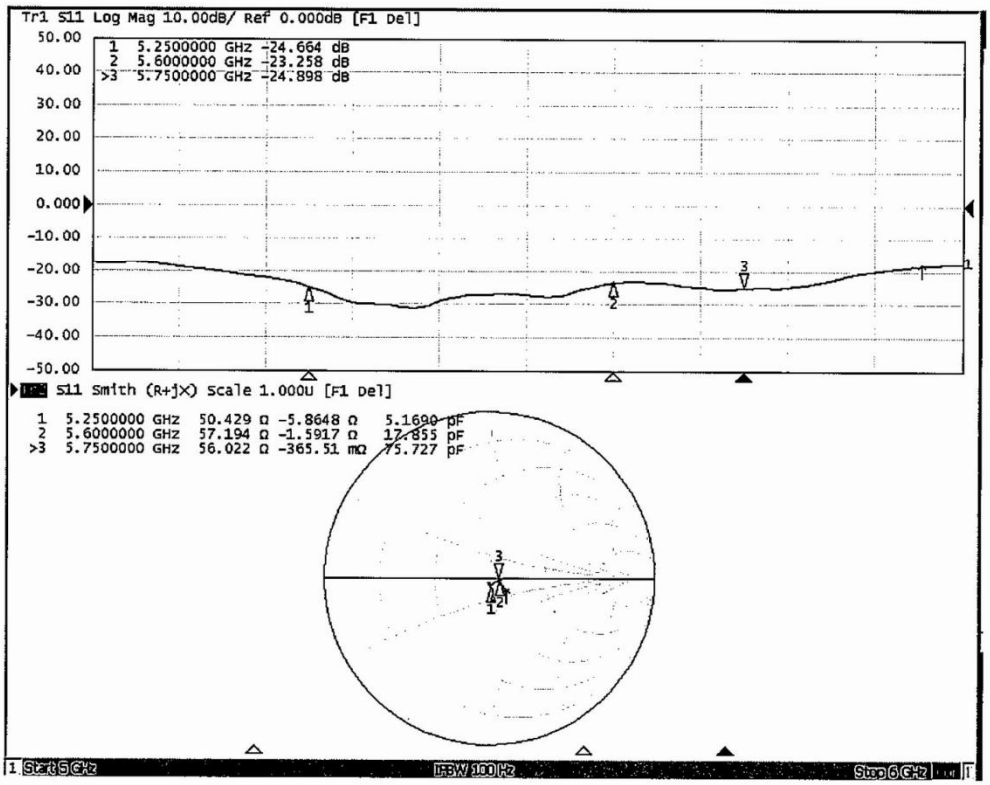
Impedance Measurement Plot for Body TSL



Certificate No: Z17-97001 Page 14 of 14

ANNEX G:DAE4 Calibration Certificate

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client TA-SH (Auden) **Certificate No: DAE4-1291_Dec18**

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 1291
Calibration procedure(s)	QA CAL-06.v29 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	December 04, 2018

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	03-Sep-18 (No:23488)	Sep-19
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	04-Jan-18 (in house check)	In house check: Jan-19
Calibrator Box V2.1	SE UMS 006 AA 1002	04-Jan-18 (in house check)	In house check: Jan-19

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	i.v.

Issued: December 4, 2018

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: DAE4-1291_Dec18 Page 1 of 5

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range:	1LSB =	6.1μV ,	full range =	-100...+300 mV
Low Range:	1LSB =	61nV ,	full range =	-1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	402.580 ± 0.02% (k=2)	403.249 ± 0.02% (k=2)	403.163 ± 0.02% (k=2)
Low Range	3.97560 ± 1.50% (k=2)	3.97886 ± 1.50% (k=2)	3.97558 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	164.5 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200038.51	1.95	0.00
Channel X	+ Input	20006.61	1.29	0.01
Channel X	- Input	-20003.34	2.94	-0.01
Channel Y	+ Input	200036.77	0.05	0.00
Channel Y	+ Input	20003.65	-1.54	-0.01
Channel Y	- Input	-20006.11	0.22	-0.00
Channel Z	+ Input	200035.08	-1.41	-0.00
Channel Z	+ Input	20002.62	-2.58	-0.01
Channel Z	- Input	-20006.40	-0.06	0.00

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.29	0.31	0.02
Channel X	+ Input	201.13	0.32	0.16
Channel X	- Input	-198.59	0.30	-0.15
Channel Y	+ Input	2000.40	-0.49	-0.02
Channel Y	+ Input	200.21	-0.66	-0.33
Channel Y	- Input	-199.89	-0.99	0.50
Channel Z	+ Input	2000.44	-0.41	-0.02
Channel Z	+ Input	199.70	-1.05	-0.52
Channel Z	- Input	-200.88	-1.78	0.89

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	10.02	7.91
	- 200	-6.52	-8.20
Channel Y	200	14.18	13.58
	- 200	-15.10	-15.62
Channel Z	200	-17.07	-17.23
	- 200	14.74	14.83

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-0.01	-4.47
Channel Y	200	7.58	-	0.48
Channel Z	200	11.17	4.87	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	16117	16241
Channel Y	15930	16718
Channel Z	16177	17128

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	-0.59	-1.81	0.89	0.47
Channel Y	1.17	-0.04	2.05	0.45
Channel Z	-1.12	-2.70	0.51	0.57

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	–0.01	-8	-9

ANNEX H:The EUT Appearances and Test Configuration

Front Side

Back Side

a: EUT

Picture 4: Constituents of EUT

Picture 5: Back Side, the distance from handset to the bottom of the Phantom is 0mm

Picture 6: Front Side, the distance from handset to the bottom of the Phantom is 0mm

Picture 7: Left Side, the distance from handset to the bottom of the Phantom is 0mm

Picture 8: Right Side, the distance from handset to the bottom of the Phantom is 0mm

Picture 9: Top Side, the distance from handset to the bottom of the Phantom is 0mm