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COMPLIANCE TEST SOLUTIONS

EMC TEST SOLUTIONS

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IEC 61000-4-39 WITH NSG 4070D

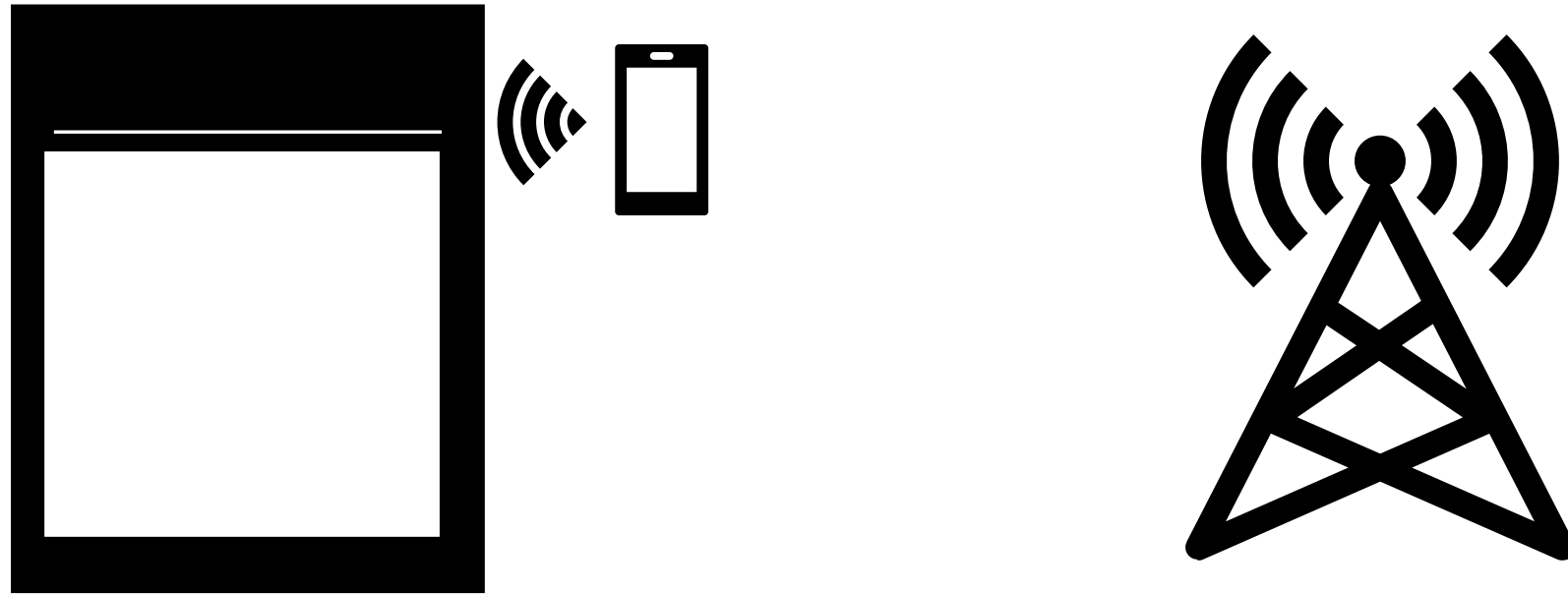
AHMED ALTANANY

- Introduction/Scope of the standard
- Level
- Coupling Devices and selection
- Calibration Setup
 - CDN/CDN S
 - KEM Clamp
 - CIP 150 Ohm and 50 Ohm system
- Testing
- Running the calibration and testing with NSG 4070D



SCOPE OF THE STANDARD

- The test method in this document describes a consistent method to assess the immunity of an equipment or system against RF signal in close proximity



INTRODUCTION

- ▀ Examples of RF sources in the near field
- ▀ generated by motors, power transformers, switching power supplies, higher-powered
- ▀ electronic article surveillance (EAS) gates or transmitters of radio-frequency identification
- ▀ (RFID) systems, inductive charging systems and near field communication (NFC) devices
- ▀ Wireless services (DECT, mobile phones, UMTS/WiFi/WiMAX/ Bluetooth etc.) see table on the right

Frequency band in MHz	Service
380 to 390	TETRA 400
430 to 470	GMRS 460, FRS 460
704 to 787	LTE Band 13, 17
800 to 960	GSM 800/900, TETRA 800, iDEN 820, CDMA 850, LTE Band 5
1447.9 to 1462.9	LTE Band 21
1700 to 1990	GSM 1800, CDMA 1900, GSM 1900, DECT, LTE Band (1, 3, 4, 25), UMTS
2400 to 2570	Bluetooth, WLAN, 802.11 b/g/n, RFID 2450, LTE Band 7
5100 to 5800	WLAN 802.11 a/n



INTRODUCTION

- There is a possibility that such an RF source could come within a short distance and affect the environment. Critical situations are in airplanes, cars and in the medical environment.
- The advice to switch off the devices is often not possible.
- The way out is to make the devices immune against near field disturbances.

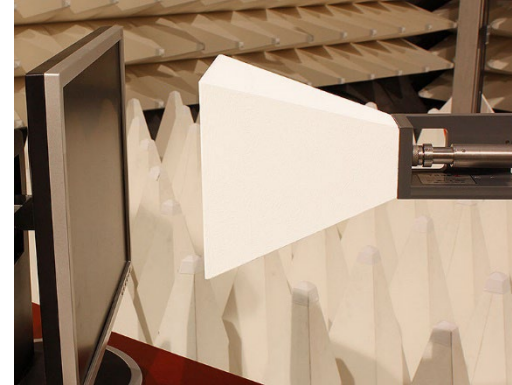
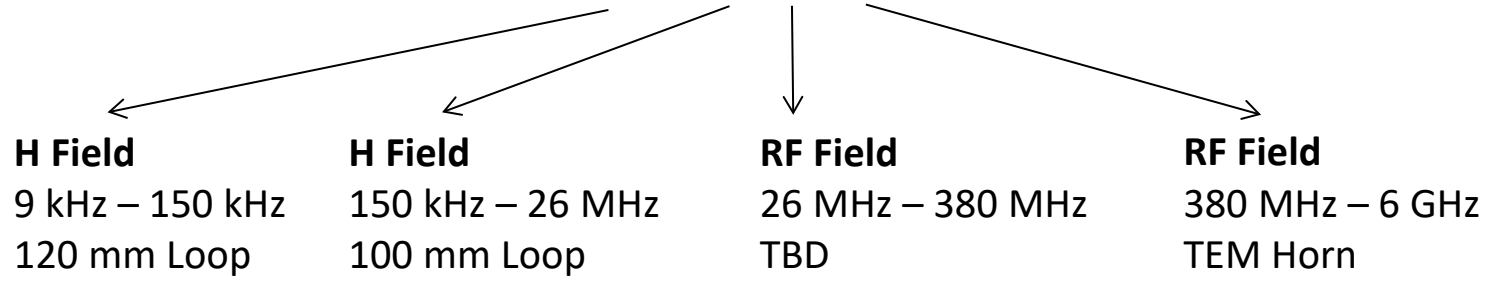


STANDARD REQUIREMENTS

- Frequency: from 9 kHz to 150 kHz, 150 kHz to 26 MHz, and from 230 MHz to 6 GHz
- Frequency Step Size: 10 Hz, 100 Hz and 1000 Hz depends on the frequency
- System impedance: Common mode 150 Ω
- Levels: 1 A/m, 3 A/m, 10 A/m and 30 A/m with ± 10 % tolerance
- Modulation: AM modulation 1 kHz (± 100 Hz) 80 % (+5 %/ - 20 %), or PM modulation with 50% duty cycle @ 2 Hz or 1 kHz, 20 dB on/off ratio
- Dwell Time: ≥ 2 s
- Coupling Device: radiation loop and Horn Antenna
- Distance: 50 mm ± 3 mm
- Generator output impedance: 50 Ω
- Harmonics: ≥ 6 dBc for CW up to 3rd Harmonic



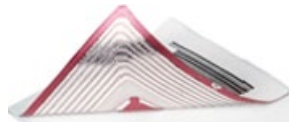
Testing IEC 61000-4-39



Test procedures 61000-4-39

Magnetic field

9 kHz – 150 kHz – 26 MHz
Loop



RF Field

26 MHz – 385 MHz
TBD

RF Field

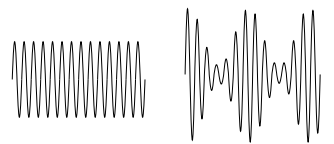
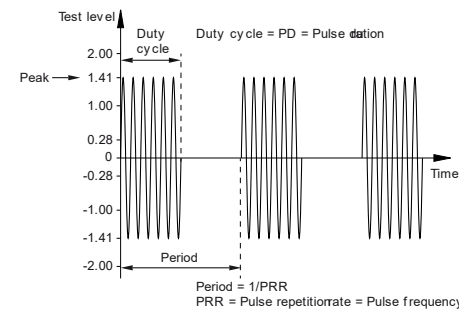
385 MHz – 6 GHz
TEM Horn



IEC 61000-4-39 OVERVIEW

IEC 61000-4-39

	9 kHz to 150 kHz Magnetic Field Immunity	150 kHz to 26 MHz Magnetic Field Immunity	26 MHz to 380 MHz RF Field Immunity	380 MHz to 6 GHz RF Field Immunity
Field Generation	Radiation Loop	Radiation Loop		Radiation Loop
Diameter	120 mm ± 10 mm	100 mm ± 10 mm		--
Number of turns	20	3		--
Distance to EUT	50 mm ± 3 mm	50 mm ± 3 mm		100 mm ± 5 mm
Sensor	Field sensor probe	Field sensor probe		RF Field sensor
Diameter	40 mm ± 2 mm	40 mm ± 2 mm		--
Number of turns	51	1		--
Test levels	A/m	A/m		A/m
	1, 3, 10, 30, special	0.1, 0.3, 1, 3, special		10, 30, 100, 300, special
Modulation	AM	PM		PM
Frequency	1 kHz	2 Hz, 1 kHz		2 Hz, 217 Hz, 1 kHz
Mod. Parameter	80 %	50 % duty cycle		50 % duty cycle
On/ off ratio	--	20 dB		20 dB
Level calibration	CW	CW		CW



IEC 61000-4-39 OVERVIEW

IEC 61000-4-39

9 kHz to 150 kHz Magnetic Field Immunity

Field Generation	Radiation Loop
Diameter	120 mm ± 10 mm
Number of turns	20
Distance to EUT	50 mm ± 3 mm
Sensor	Field sensor probe
Diameter	40 mm ± 2 mm
Number of turns	51



150 kHz to 26 MHz Magnetic Field Immunity

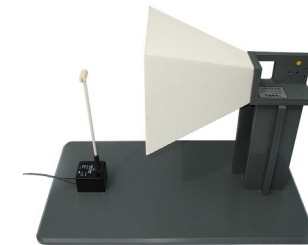
Field Generation	Radiation Loop
Diameter	100 mm ± 10 mm
Number of turns	3
Distance to EUT	50 mm ± 3 mm
Sensor	Field sensor probe
Diameter	40 mm ± 2 mm
Number of turns	1



26 MHz to 380 MHz RF Field Immunity

380 MHz to 6 GHz RF Field Immunity

Field Generation	Radiation Loop
Diameter	--
Number of turns	--
Distance to EUT	100 mm ± 5 mm
Sensor	RF Field sensor
Diameter	--
Number of turns	--



APPLICATION IEC 60601-1-2

- First use of IEC 61000-4-39 in IEC 60601-1-2
- IEC 60601-1-2 with the title: Medical electrical equipment – Part 1-2: General requirements for basic safety and essential performance – Collateral Standard: Electromagnetic disturbances – Requirements and tests.



IEC 60601-1-2 (MEDICAL PRODUCTS) OVERVIEW

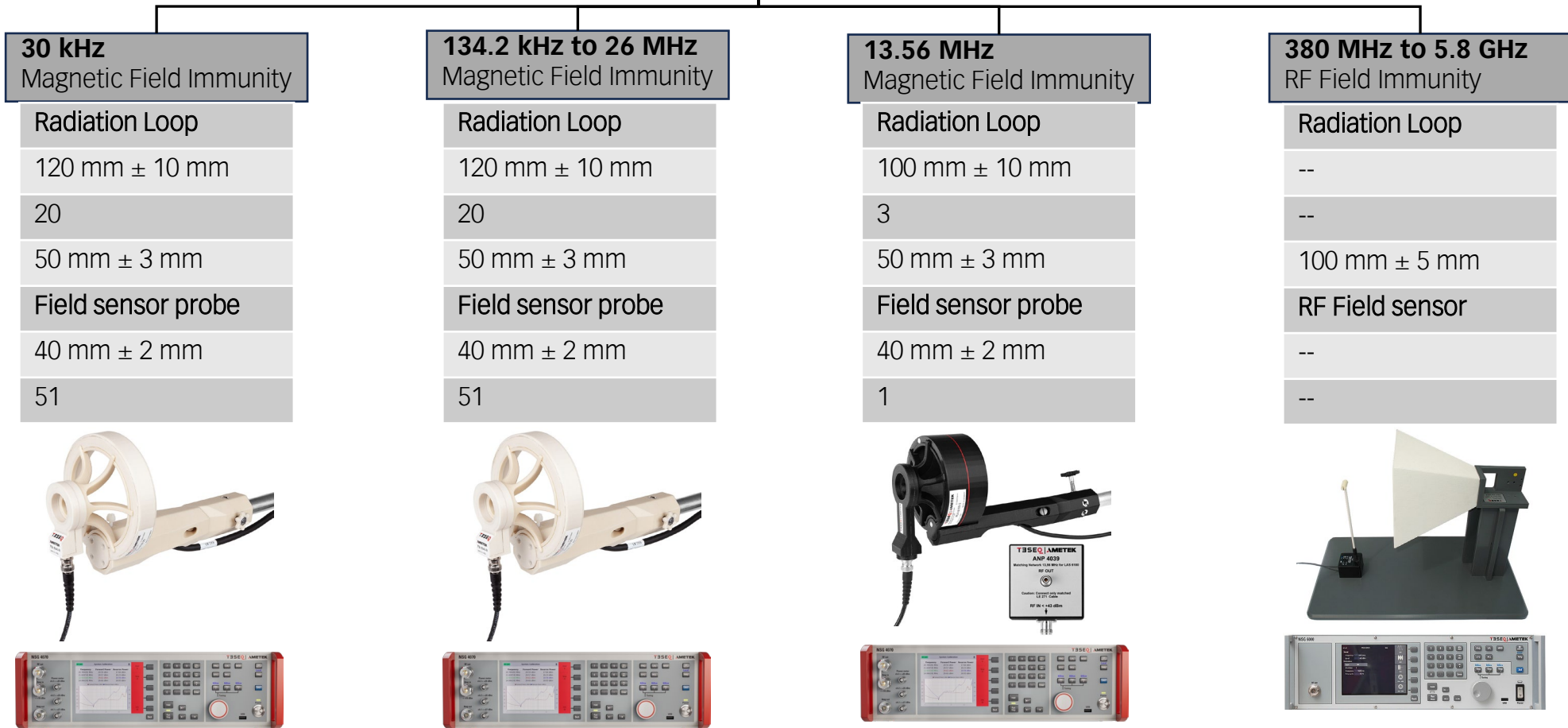
IEC 60601-1-2

	30 kHz Magnetic Field Immunity	134.2 kHz to 26 MHz Magnetic Field Immunity	13.56 MHz Magnetic Field Immunity	380 MHz to 5.8 GHz RF Field Immunity
Field Generation	Radiation Loop	Radiation Loop	Radiation Loop	Radiation Loop
Diameter	120 mm ± 10 mm	120 mm ± 10 mm	100 mm ± 10 mm	--
Number of turns	20	20	3	--
Distance to EUT	50 mm ± 3 mm	50 mm ± 3 mm	50 mm ± 3 mm	100 mm ± 5 mm
Sensor	Field sensor probe	Field sensor probe	Field sensor probe	RF Field sensor
Diameter	40 mm ± 2 mm	40 mm ± 2 mm	40 mm ± 2 mm	--
Number of turns	51	51	1	--
Test levels	A/m	A/m	A/m	V/m
1	8	65	7.5	9 to 28
Modulation	--	PM	PM	PM
Frequency	--	2.1 kHz	50 kHz	18 Hz, 217 Hz
Mod. Parameter	--	50 % duty cycle	50 % duty cycle	50 % duty cycle
On/ off ratio	--	--	--	--
Level calibration	CW	CW	CW	CW



IEC 60601-1-2 AMETEK OFFERING

IEC 60601-1-2



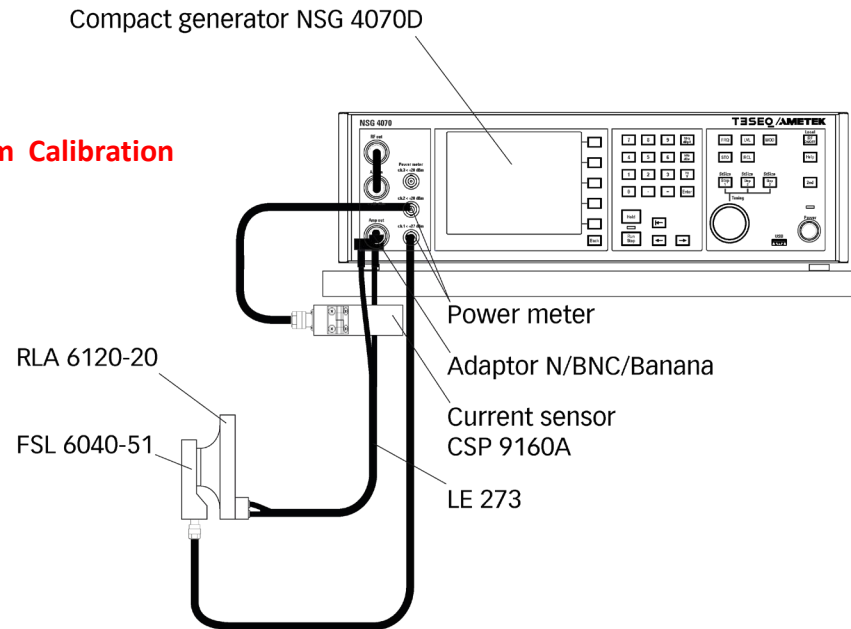
Equipment



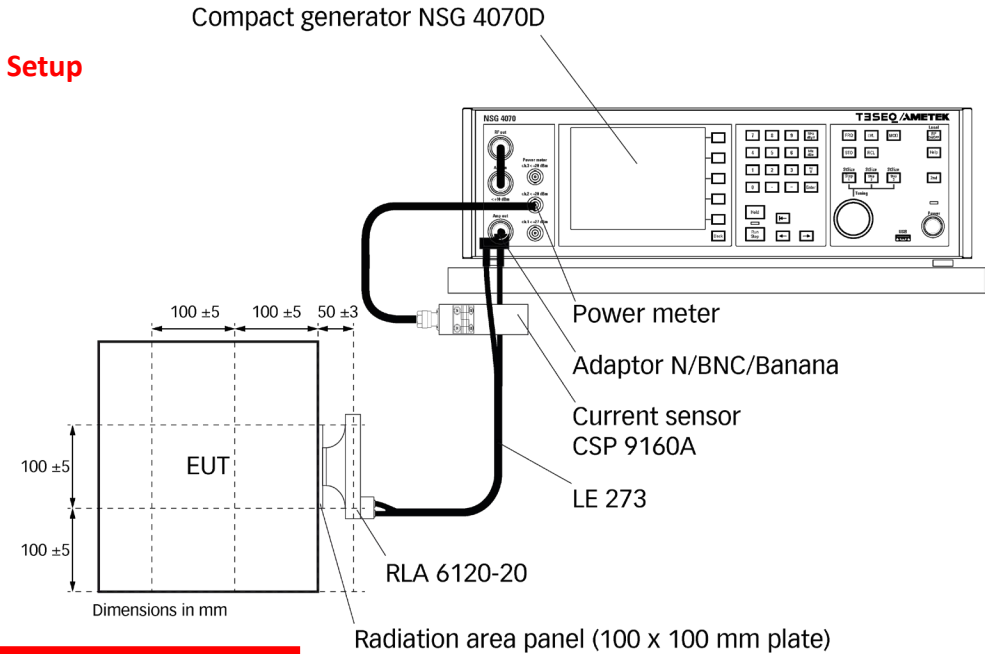
MEASUREMENTS FROM 9 KHZ TO 150 KHZ

NSG 4070D-A400M-100 + LAS 6120

System Calibration



Test Setup



Model	Item Number
NSG 4070D-A400M-100	262106
NSG 4070D-LFCP license	56-262143
icd.control (optional)	257512
LAS 6120	258280



FW SETTINGS (9 KHZ TO 150 KHZ)

Select the standard

- Select the appropriate test severity (level)
- Test Setup allows you to choose the loop type, amplifier and edit the dwell time

Standards Menu		Device
NSG 4070D	Amplifier: 80 W - 150 kHz - 230 MHz	↔
DO-160G, Section 20	RF conducted immunity testing for airborne equipment with BCI	>
ISO 7637-4, Pulse A	Pulsed sinusoidal disturbances on shielded HV power lines	>
IEC 61000-4-39	Magnetic fields immunity in proximity test 9 kHz - 150 kHz	>
T3ESEO / AMETEK		Scroll ↓

IEC 61000-4-39 LF Main Menu		Test Severity
Level		...
Start:	1.0 A/m	1
Stop:	1.0 A/m	
Frequency Sweep: Linear		Loop Type
Start:	9.000 kHz	LAS6120 IEC 61000-4-39 9kHz-150kHz
Stop:	150.000 kHz	
Step:	10.000 kHz	
Dwell:	2000 ms	
Modulation: AM		Amplifier
Frequency:	1000.0 Hz	External
Depth:	80.0 %	



FW SETTINGS (9 KHZ TO 150 KHZ)

- Test Setup allows you to choose the loop type, amplifier and edit the dwell time

RF OFF IEC 61000-4-39 LF Main Menu		Test Severity
Level		...
Start:	1.0 A/m	1
Stop:	1.0 A/m	
Frequency Sweep: Linear		Loop Type
Start:	9.000 kHz	
Stop:	150.000 kHz	LAS6120
Step:	10.000 kHz	IEC 61000-4-39
Dwell:	2000 ms	9kHz-150kHz
Modulation: AM		Amplifier
Frequency:	1000.0 Hz	
Depth:	80.0 %	External

RF OFF Immunity Test Setup		Test Severity
Level		1
Start:	1.0 A/m	1
Stop:	1.0 A/m	
Frequency Sweep: Linear		Loop Type
Start:	9.000 kHz	
Stop:	150.000 kHz	LAS6120
Step:	10.000 kHz	IEC 61000-4-39
Dwell:	2000 ms	9kHz-150kHz
Modulation: AM		Amplifier
Frequency:	1000.0 Hz	
Depth:	80.0 %	Internal

RF OFF Select Loop Type		Test Severity
Level		...
Start:	1.0 A/m	1
Stop:	1.0 A/m	
Frequency Sweep: Linear		Loop Type
Start:	9.000 kHz	
Stop:	150.000 kHz	LAS6120
Step:	10.000 kHz	IEC 61000-4-39
Dwell:	2000 ms	9kHz-150kHz
Modulation: AM		Amplifier
Frequency:	1000.0 Hz	
Depth:	80.0 %	Internal
RF OFF Select Amplifier		Test Severity
Level		...
Start:	1.0 A/m	1
Stop:	1.0 A/m	
Frequency Sweep: Linear		Loop Type
Start:	9.000 kHz	
Stop:	150.000 kHz	LAS6120
Step:	10.000 kHz	IEC 61000-4-39
Dwell:	2000 ms	9kHz-150kHz
Modulation: AM		Amplifier
Frequency:	1000.0 Hz	
Depth:	80.0 %	Internal
RF OFF Immunity Test Setup		Test Severity
Level		1
Start:	0.1 A/m	1
Stop:	0.1 A/m	
Frequency Sweep: Linear		Loop Type
Start:	150.000 kHz	
Stop:	26.000000 MHz	LAS6100
Step:	100.000 kHz	IEC 61000-4-39
Dwell:	2000 ms	150kHz-26MHz
Modulation: Pulse - T1		Amplifier
Frequency:	1000.0 Hz	
Duty Cycle:	50.0 %	Internal



FW SETTINGS (9 KHZ TO 150 KHZ)

Calibration

Sends the user to the calibration routine:

- System calibration
- Saturation Check
- Probe calibration

RF OFF IEC 61000-4-39 LF Main Menu

Level	Test Severity	Test Severity ...
Start: 1.0 A/m	1	Test Setup >
Stop: 1.0 A/m		Monitoring Setup >
Frequency Sweep: Linear	Loop Type	Calibration >
Start: 9.000 kHz	LAS6120 IEC 61000-4-39 9kHz-150kHz	Results >
Stop: 150.000 kHz		
Step: 10.000 kHz		
Dwell: 2000 ms		
Modulation: AM	Amplifier	
Frequency: 1000.0 Hz	External	
Depth: 80.0 %		

RF OFF Immunity Test Calibration

Level	Test Severity	System Calibration >
Start: 1.0 A/m	1	Saturation Check >
Stop: 1.0 A/m		Probe Calibration >
Frequency Sweep: Linear	Loop Type	
Start: 9.000 kHz	LAS6120 IEC 61000-4-39 9kHz-150kHz	Show Cal Files
Stop: 150.000 kHz		
Step: 10.000 kHz		
Dwell: 2000 ms		
Modulation: AM	Amplifier	
Frequency: 1000.0 Hz	Internal	
Depth: 80.0 %		

RF OFF System Calibration

Frequency	Forward Power	Reverse Power
--- MHz	--- dBm	--- dBm
--- MHz	--- dBm	--- dBm
--- MHz	--- dBm	--- dBm

RF OFF Immunity Saturation Check

Frequency: 100.000000 MHz

Check: unchecked

RF OFF Probe Calibration

Passive

Frequency	Passive Att.
119.000 kHz	18.74 dB
129.000 kHz	18.72 dB
139.000 kHz	18.74 dB
149.000 kHz	18.75 dB
150.000 kHz	19.03 dB



FW SETTINGS (9 KHZ TO 150 KHZ)

Results will go the test menu

- It will be activated only with hard key



RF OFF IEC 61000-4-39 LF Main Menu

Level	Test Severity
Start: 1.0 A/m	1
Stop: 1.0 A/m	
Frequency Sweep: Linear	Loop Type
Start: 9.000 kHz	LAS6120
Stop: 150.000 kHz	IEC 61000-4-39
Step: 10.000 kHz	9kHz-150kHz
Dwell: 2000 ms	
Modulation: AM	Amplifier
Frequency: 1000.0 Hz	External
Depth: 80.0 %	

Test Severity ...
Test Setup >
Monitoring Setup >
Calibration >
Results >

RF OFF Results

Frequency: 4.000 kHz Level: 1.00 mA

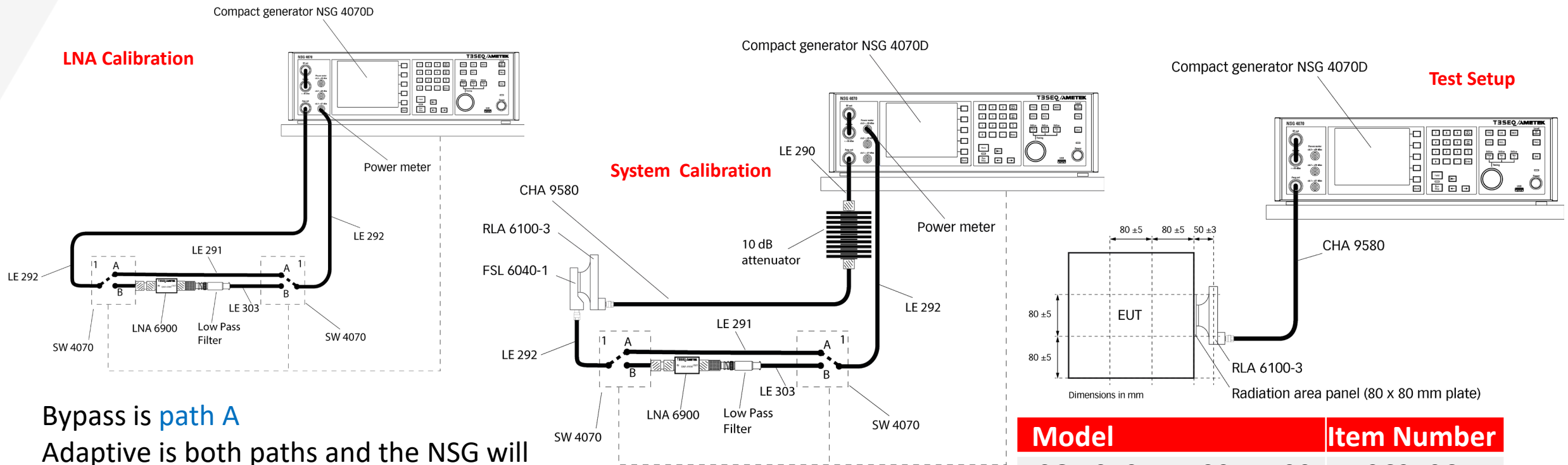
Events: none

The graph displays a flat line at 0 on a logarithmic scale from 0.01 to 1,000 kHz. The y-axis ranges from 0 to 25. Two horizontal red lines are present at approximately 5 and 20. A bar chart at the bottom shows three segments: purple, blue, and green.



MEASUREMENTS FROM 150 KHZ TO 26 KHZ

NSG 4070D-A400M-100 + NSG 4070D-LFCP Kit + LAS 6100



Bypass is **path A**

Adaptive is both paths and the NSG will control the Switch

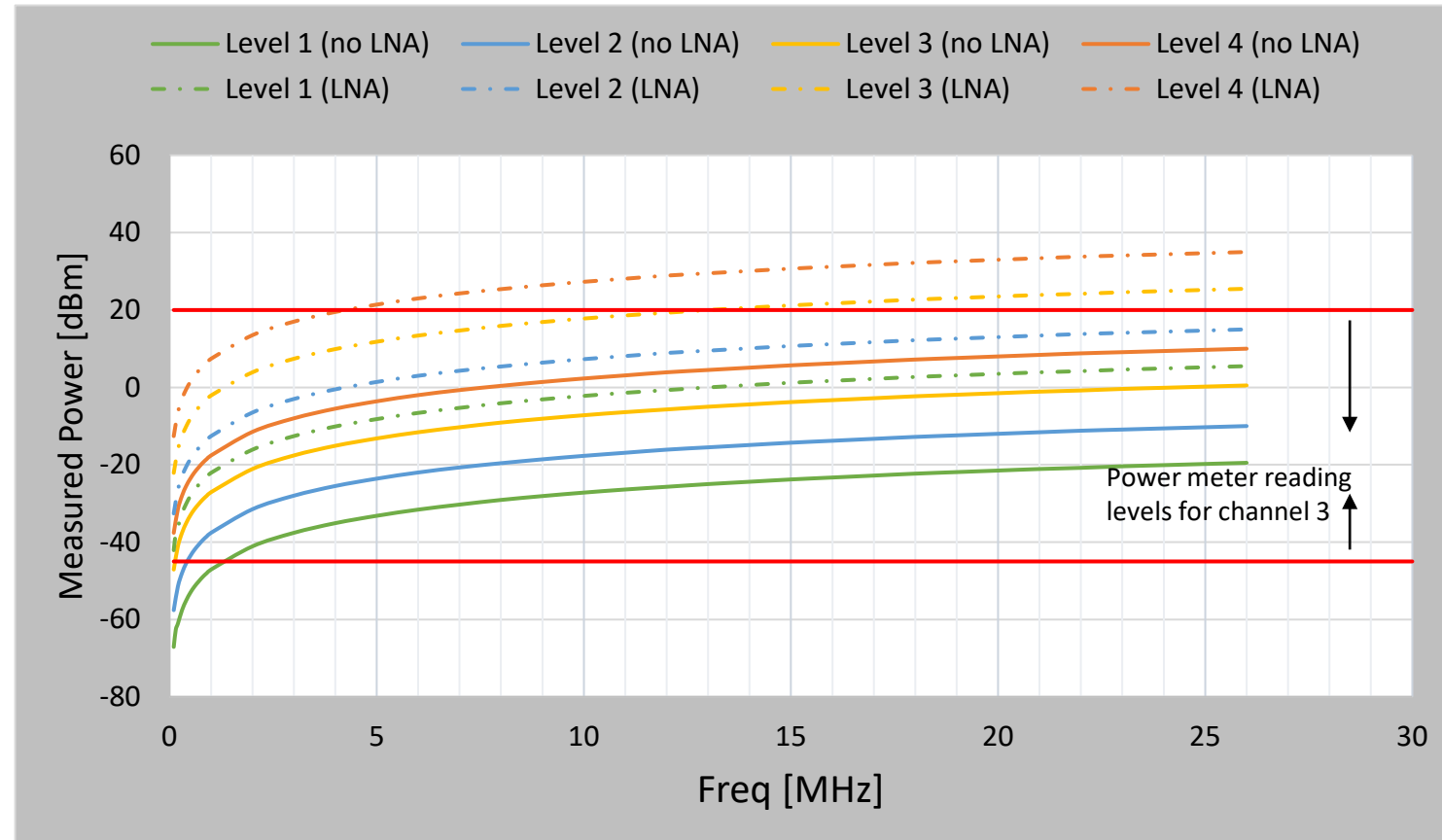
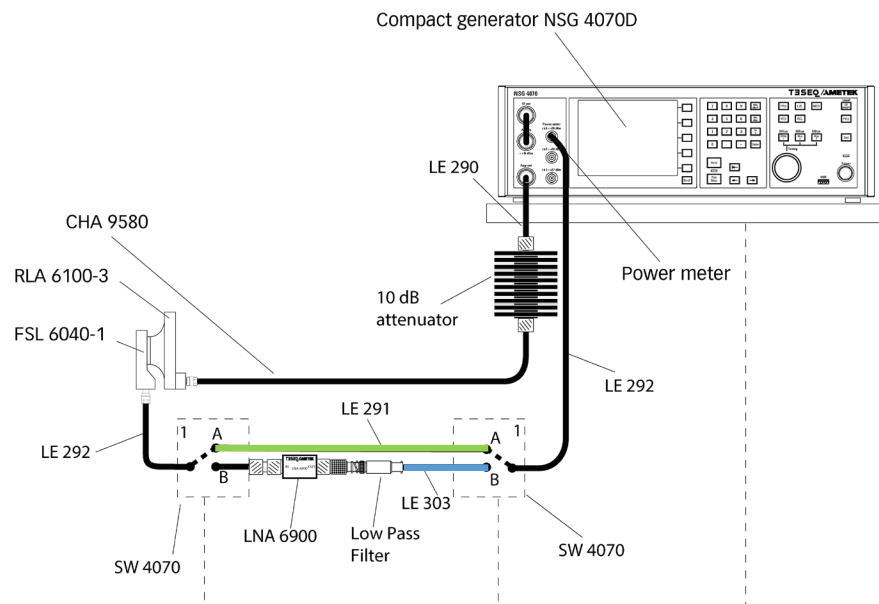
For pre-compliance, no need for the kit and you can do over-calibration method

Model	Item Number
NSG 4070D-A400M-100	262106
NSG 4070D-LFCP license	56-262143
icd.control (optional)	257512
LAS 6100	258281
NSG 4070D-LFCP Kit	262121



MEASUREMENTS FROM 150 KHZ TO 26 KHZ

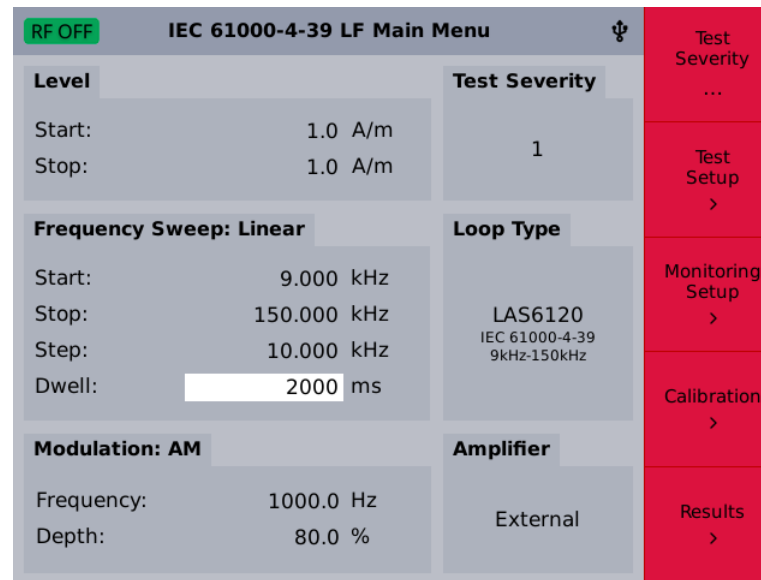
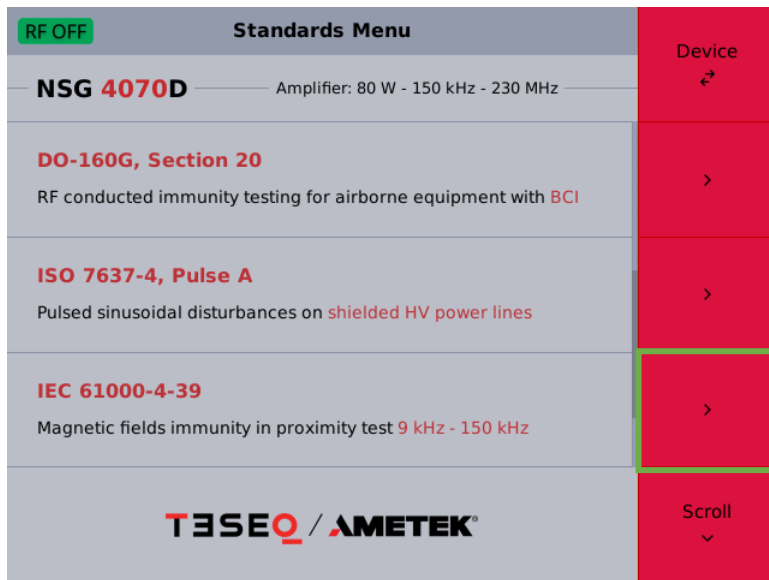
- ▀ The power from sensor loop (FSL 4040-1) is below all channel meters minimum reading.
 - LFCP kit is needed
- ▀ For low level -> LNA path (A)
- ▀ For high level -> Bypass path (B)



FW SETTINGS (150 KHZ TO 26 KHZ)

Select the standard

- Select the appropriate test severity (level)
- Test Setup allows you to choose the loop type, amplifier and edit the dwell time



FW SETTINGS (150 KHZ TO 26 KHZ)

- Test Setup allows you to choose the loop type, amplifier and edit the dwell time

RF OFF IEC 61000-4-39 LF Main Menu		Test Severity
Level		...
Start:	1.0 A/m	1
Stop:	1.0 A/m	
Frequency Sweep: Linear		Loop Type
Start:	9.000 kHz	
Stop:	150.000 kHz	LAS6120
Step:	10.000 kHz	IEC 61000-4-39
Dwell:	2000 ms	9kHz-150kHz
Modulation: AM		Amplifier
Frequency:	1000.0 Hz	
Depth:	80.0 %	External

RF OFF Immunity Test Setup		Test Severity
Level		1
Start:	1.0 A/m	1
Stop:	1.0 A/m	
Frequency Sweep: Linear		Loop Type
Start:	9.000 kHz	
Stop:	150.000 kHz	LAS6120
Step:	10.000 kHz	IEC 61000-4-39
Dwell:	2000 ms	9kHz-150kHz
Modulation: AM		Amplifier
Frequency:	1000.0 Hz	
Depth:	80.0 %	Internal

RF OFF Select Loop Type		Test Severity
Level		...
Start:	1.0 A/m	1
Stop:	1.0 A/m	
Frequency Sweep: Linear		Loop Type
Start:	9.000 kHz	
Stop:	150.000 kHz	LAS6120
Step:	10.000 kHz	IEC 61000-4-39
Dwell:	2000 ms	9kHz-150kHz
Modulation: AM		Amplifier
Frequency:	1000.0 Hz	
Depth:	80.0 %	Internal

RF OFF Select Amplifier		Test Severity
Level		...
Start:	1.0 A/m	1
Stop:	1.0 A/m	
Frequency Sweep: Linear		Loop Type
Start:	9.000 kHz	
Stop:	150.000 kHz	LAS6120
Step:	10.000 kHz	IEC 61000-4-39
Dwell:	2000 ms	9kHz-150kHz
Modulation: AM		Amplifier
Frequency:	1000.0 Hz	
Depth:	80.0 %	Internal

RF OFF Immunity Test Setup		Test Severity
Level		1
Start:	0.1 A/m	1
Stop:	0.1 A/m	
Frequency Sweep: Linear		Loop Type
Start:	150.000 kHz	
Stop:	26.000000 MHz	LAS6100
Step:	100.000 kHz	IEC 61000-4-39
Dwell:	2000 ms	150kHz-26MHz
Modulation: Pulse - T1		Amplifier
Frequency:	1000.0 Hz	
Duty Cycle:	50.0 %	Internal



FW SETTINGS (150 KHZ TO 26 KHZ)

Calibration

Sends the user to the calibration routine:

System calibration, Calibration method decides if:

- LNA will be used or
- Over-Calibration: Calibration with high level and interpolate the low level (This is pre-compliance and does not require license or NSG 4070D LFCP kit).

RF OFF IEC 61000-4-39 LF Main Menu

Level	Test Severity	Test Severity ...
Start: 1.0 A/m	1	Test Setup >
Stop: 1.0 A/m		Monitoring Setup >
Frequency Sweep: Linear	Loop Type	Calibration >
Start: 9.000 kHz	LAS6120	Results >
Stop: 150.000 kHz	IEC 61000-4-39	
Step: 10.000 kHz	9kHz-150kHz	
Dwell: 2000 ms		
Modulation: AM	Amplifier	
Frequency: 1000.0 Hz	External	
Depth: 80.0 %		

RF OFF Immunity Test Calibration

Level	Test Severity	System Calibration >
Start: 0.1 A/m	1	Saturation Check >
Stop: 0.1 A/m		ByPass/LNA Calibration >
Frequency Sweep: Linear	Loop Type	Show Cal Files
Start: 150.000 kHz	LAS6100	
Stop: 26.000000 MHz	IEC 61000-4-39	
Step: 100.000 kHz	150kHz-26MHz	
Dwell: 2000 ms		
Modulation: Pulse - T1	Amplifier	
Frequency: 1000.0 Hz	Internal	
Duty Cycle: 50.0 %		

RF OFF System Calibration

Frequency	Forward Power	Reverse Power
--- MHz	--- dBm	--- dBm
--- MHz	--- dBm	--- dBm
--- MHz	--- dBm	--- dBm
--- MHz	--- dBm	--- dBm

RF OFF Immunity Saturation Check

Frequency: 100.000000 MHz

Check: unchecked

RF OFF ByPass/LNA Calibration

Adaptive

Frequency	ByPass Att.	LNA Gain
25.650000 MHz	5.70 dB	13.94 dB
25.750000 MHz	5.90 dB	13.65 dB
25.850000 MHz	6.16 dB	14.03 dB
25.950000 MHz	6.30 dB	13.65 dB
26.000000 MHz	6.24 dB	13.68 dB



FW SETTINGS (150 KHZ TO 26 KHZ)

Calibration

Sends the user to the calibration routine:

- System calibration
- Saturation Check
- ByPass/LNA Calibration
 - This cycle between bypassing the LNA or adaptive or only LNA

RF OFF IEC 61000-4-39 LF Main Menu

Level	Test Severity	Test Severity
Start: 1.0 A/m	1	...
Stop: 1.0 A/m		Test Setup >
Frequency Sweep: Linear	Loop Type	Monitoring Setup >
Start: 9.000 kHz	LAS6120	Calibration >
Stop: 150.000 kHz	IEC 61000-4-39	
Step: 10.000 kHz	9kHz-150kHz	
Dwell: 2000 ms		
Modulation: AM	Amplifier	Results >
Frequency: 1000.0 Hz	External	
Depth: 80.0 %		

RF OFF Immunity Test Calibration

Level	Test Severity	System Calibration >
Start: 0.1 A/m	1	Saturation Check >
Stop: 0.1 A/m		ByPass/LNA Calibration >
Frequency Sweep: Linear	Loop Type	Show Cal Files
Start: 150.000 kHz	LAS6100	
Stop: 26.000000 MHz	IEC 61000-4-39	
Step: 100.000 kHz	150kHz-26MHz	
Dwell: 2000 ms		
Modulation: Pulse - T1	Amplifier	
Frequency: 1000.0 Hz	Internal	
Duty Cycle: 50.0 %		

RF OFF System Calibration

Frequency	Forward Power	Reverse Power
--- MHz	--- dBm	--- dBm
--- MHz	--- dBm	--- dBm
--- MHz	--- dBm	--- dBm
--- MHz	--- dBm	--- dBm

RF OFF Immunity Saturation Check

Frequency: 100.000000 MHz

Check: unchecked

RF OFF ByPass/LNA Calibration

Adaptive

Frequency	ByPass Att.	LNA Gain
25.650000 MHz	5.70 dB	13.94 dB
25.750000 MHz	5.90 dB	13.65 dB
25.850000 MHz	6.16 dB	14.03 dB
25.950000 MHz	6.30 dB	13.65 dB
26.000000 MHz	6.24 dB	13.68 dB



FW SETTINGS (150 KHZ TO 26 KHZ)

Results will go the test menu

- It will be activated only with hard key



RF OFF IEC 61000-4-39 LF Main Menu

Level	Test Severity	Test Severity ... Test Setup > Monitoring Setup > Calibration > Results >
Start: 1.0 A/m	1	
Stop: 1.0 A/m		
Frequency Sweep: Linear	Loop Type	
Start: 9.000 kHz	LAS6120	
Stop: 150.000 kHz	IEC 61000-4-39	
Step: 10.000 kHz	9kHz-150kHz	
Dwell: 2000 ms		
Modulation: AM	Amplifier	
Frequency: 1000.0 Hz	External	
Depth: 80.0 %		

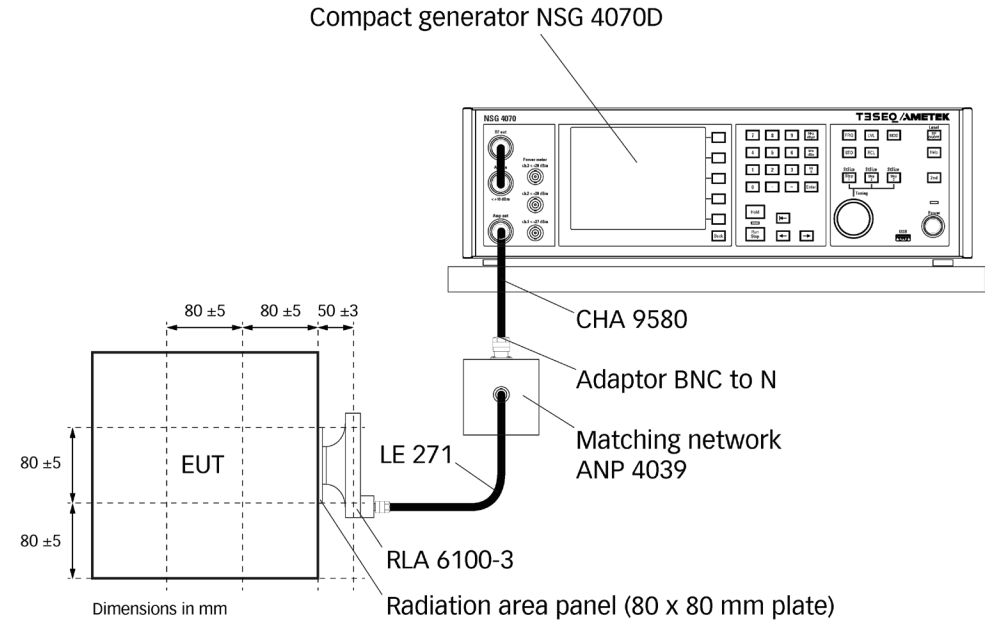
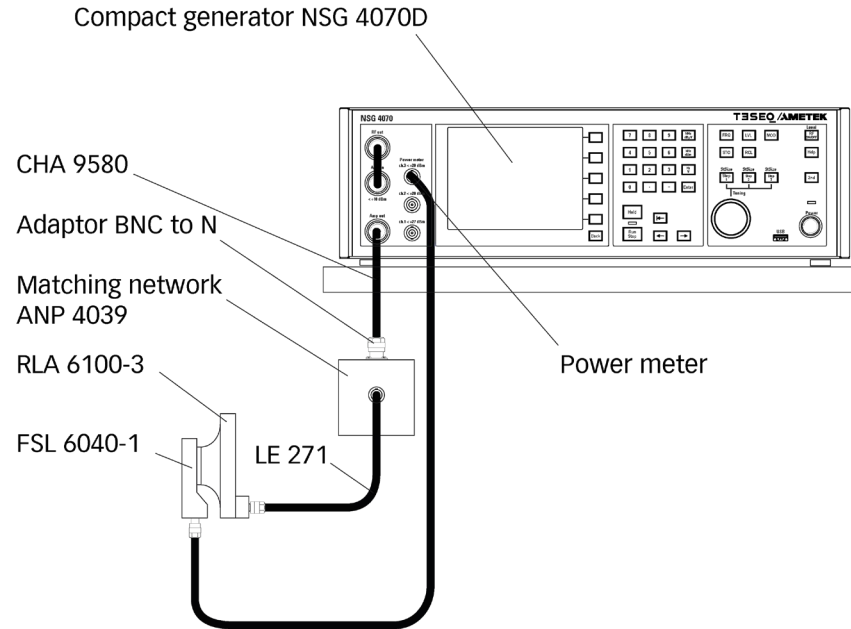
RF OFF Results

Frequency: 4.000 kHz Level: 1.00 mA

Events: none



MEASUREMENTS FOR 13.56 MHZ



Model	Item Number
NSG 4070D-A400M-100	262106
NSG 4070D-LFCP license	56-262143
icd.control (optional)	257512
LAS 6100	258281

ADVANTAGES OF THE SOLUTION WITH NSG 4070D

- Dedicated system for compliance testing
- Time saving due to Pre-programmed routine
- Reduces the risk of incorrect measurements and destroyed hardware through software guidance and recommended hardware
- NSG 4070D allows movement around a larger EUT
- Optional icd.control software for advanced requirements incl. additional application and standards
- Combination with directional coupler and power amplifier allows testing 4-6, BCI and more



Thank you!

