Chapter 2
Performance Test

Ambient temperature: 23 ± 10 °C (73 ± 18 °F)

Warm-up time of UPL: 1 hour

2.1 Recommended Measurement Equipment

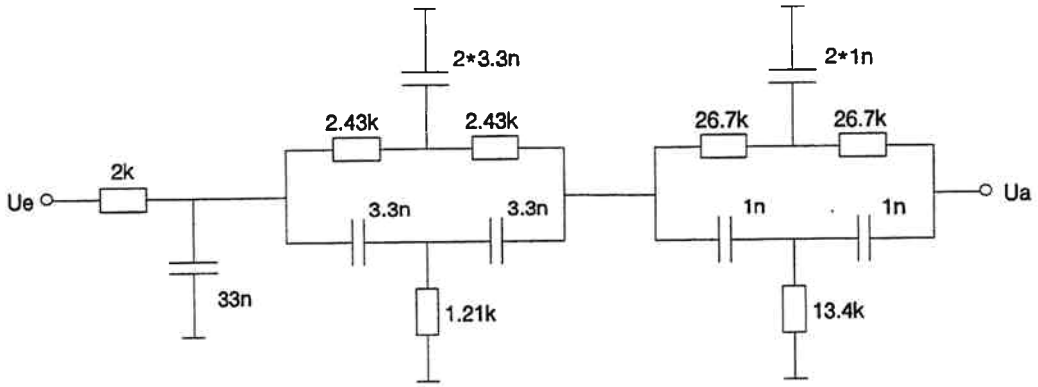
Measuring instrument	Specifications		Example
Digital Multimeter	AC, DC, Ohm measurement		HP3458A
as AC Voltmeter	2 Hz – 110 kHz		
	15 mV – 24 V		
	±0.06 %	10 Hz – 20 kHz	
	±0.15 %	20 kHz – 100 kHz	
	Input impedance > 1 MΩ		
as DC Voltmeter	±0.05 %	100 mV – 100 V	
as Ohm meter	±0.025 %	5 Ω – 200 kΩ	
Frequency counter	±5 ppm, 10 Hz – 110 kHz		Philips PM6680
Audio Analyzer	THD+N	Bandwidth	R&S UPL (DUT)
	< –105 dB	20 kHz	
	< –88 dB	100 kHz	
	Fundamental < 20 kHz		
Audio Analyzer	THD	Fundamental	R&S UPD
	< –96 dB	10 Hz – 20 Hz	
	< –100 dB	20 Hz – 100 Hz	
	< –110 dB	100 Hz – 7 kHz	
	< –92 dB	7 kHz – 50 kHz	
	MOD DIST	Upper Freq	
	< –96 dB, (< –90 dB)	4 kHz – 15 kHz	
	< –96 dB, (< –85 dB)	15 kHz – 20 kHz	
	Lower Freq 200 Hz – 500 Hz		
	values in ( ) for Lower Freq 30 Hz – 200 Hz		
	DFD d3	Mean Freq	
	< –96 dB	5 kHz – 20 kHz	
	Diff Freq 80 Hz – 1 kHz		
	Selective rms measurement		
	20 Hz – 20 kHz		
	0.1 μV sensitivity		
Oscilloscope	Bandwidth 100 MHz, 2 Channels		TDS 410A
Square wave Gen.	TTL, 27 to 55 kHz		APN

Signal Generator 1 as Sine Generator	Sine, Multisine, Low Distortion, DC 10 Hz – 110 kHz 100 mV – 24 V, BAL 10 Ω 100 mV – 12 V, UNBAL 15 Ω	R&S UPD + UPD-B1
as Multi Sine Generator	10 Hz – 110 kHz ±50 ppm 1 mV – 24 V, BAL 10 Ω 1 mV – 12 V, UNBAL 15 Ω ±0.5 % 20 Hz - - 20 kHz ±1 % 20 kHz – 110 kHz	
as Low Distortion Generator	10 Hz – 110 kHz ±0.1 % 100 mV – 24 V, BAL 10 Ω 100 mV – 12 V, UNBAL 15 Ω ±0.5 % 20 Hz - - 20 kHz ±1 % 20 kHz – 110 kHz	
	THD Fundamental < –107 dB 10 Hz < –113 dB 25 Hz – 7 kHz < –107 dB 7 kHz – 20 kHz < –92 dB 20 kHz – 50 kHz < –86 dB 50 kHz – 100 kHz	R&S UPD
	THD+N Bandwidth < –105 dB 22 kHz < –90 dB 110 kHz	
	MOD DIST Upper Freq < –96 dB, (< –90 dB) 4 kHz – 20 kHz	
as DC Source	±100 mV – ±5 V, BAL 10 Ω	
Signal Generator 2	Sine, Multisine, Low Distortion	R&S UPL + UPL-B1 (DUT)

Measuring instrument	Specifications	Example
XLR/BNC Adapter set	2 from XLR male to BNC 2 from XLR female to BNC	UPL-Z1
Adapter	from BNC female to 2*banana jacks Order No. FJ 0099.6687.00	R&S
BNC T-junction	Order No. FJ 0017.6588.00	R&S
Junction	BNC-BNC female Order No. FJ 0017.6559.00	R&S
Termination	75 Ω, BNC Order No. FJ 0265.6862.00	RMF 2
Test cable for output resistance	Special cable with 4 Banana jacks and XLR cable-female	— —
Test cable for output balance	Special cable with BNC and XLR female cable connection, 2* 300 Ω precision resistors and 10 kΩ resistor built in	— — —
Test cable for common-mode rejection	Special cable w. BNC and XLR male cable connector built in 2* 300 Ω precision resistors	— —
Adapter	Cable connecting 1/4" phone jack to 2*BNC- or 2*XLR-male connector	—
Cables	BNC Cables Balanced Cables with XLR connectors	— —
Cable	BNC-Cable 75 Ω	—
Differential-tone lowpass (LP DFD)	passive RC lowpass for DFD d2 measurement Attenuation < 5 dB for f < 1 kHz Attenuation > 35 dB for f > 5 kHz	—
Intermodulation highpass (HP MOD DIST)	passive RC highpass for MOD DIST measurement Attenuation >40 dB for f < 500 Hz Attenuation <5 dB for f > 4 kHz	—
Notch filter (NOTCH THD)	4 passive RC notch filters for THD measurement Notch frequencies 20 Hz, 1 kHz, 7 kHz and 20 kHz Attenuation > 60 dB for the fundamental Attenuation < 10 dB for the harmonics	—
Resistance network (RES NET 1)	2 resistors 985 Ω and 995 Ω shielded construction with 3 BNC for THD, MOD DIST and DFD signal generation	—
Resistance network (RES NET 2)	2 resistors 85 Ω and 100 kΩ shielded construction with 3 BNC for THD and MOD DIST signal generation	—

Differential-tone lowpass LP DFD

Circuit diagram:



Construction:
To avoid any interference, the filter should be built in a metal housing. Use BNC connectors for input and output.

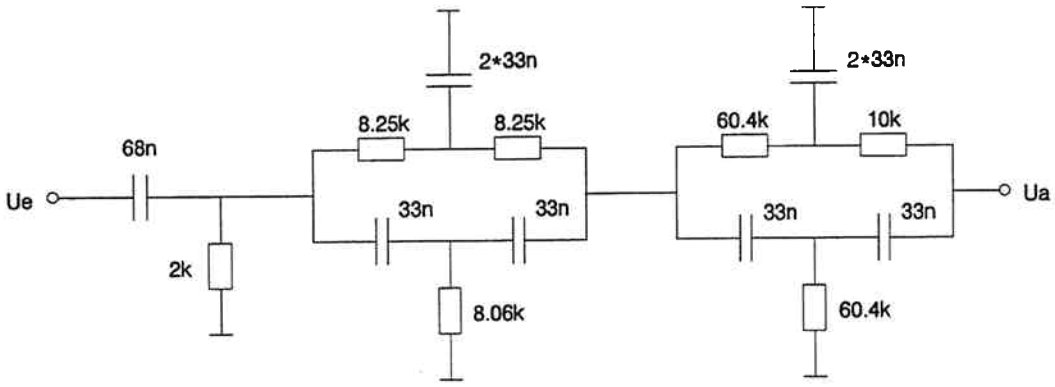
Components:

Resistors metal film, ±1 % tolerance	
Value	R&S Order No.
1.21 kΩ	RL 0083.0655.00
2.00 kΩ	RL 0083.0826.00
2.43 kΩ	RL 0083.0884.00
13.3 kΩ	RL 0082.2577.00
26.7 kΩ	RL 0083.1597.00

Capacitors Polypropylene, ±1 % tolerance	
value	R&S order no.
1.0 nF	CK 0007.7598.00
3.3 nF	CK 0007.7623.00
33 nF	CK 0007.7681.00

Intermodulation highpass HP MOD DIST

Circuit diagram:



Construction:

To avoid any interference, the filter should be built in a metal housing. Use BNC connectors for input and output.

Components:

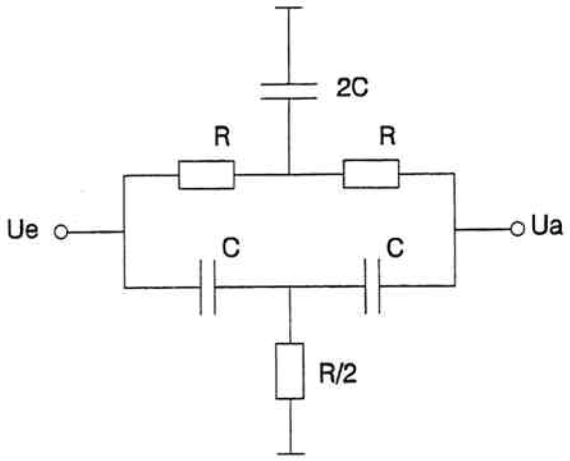
Resistors metal film, ±1 % tolerance	
Value	R&S Order No.
2.00 kΩ	RL 0084.3793.00
8.06 kΩ	RL 0083.1222.00
8.25 kΩ	RL 0083.1239.00
10.0 kΩ	RL 0083.1297.00
60.4 kΩ	RL 0083.1851.00

Capacitors Polypropylene, ±1 % tolerance	
value	R&S order no.
2.2 nF	CK 0007.7617.00
33 nF	CK 0007.7681.00

The 68 nF capacitor can be built out of two 33 nF and one 2.2 nF capacitors in parallel.

Notch filters NOTCH THD, for THD measurement of generator

Circuit diagram:



Construction:

To avoid any interference, the filter should be built in a metal housing. Use BNC connectors for input and output.

Components:

Resistors: Metal film resistors, ±0.1 % tolerance
Capacitors: Polypropylene, ±1 % tolerance

Notch frequency f_1	R	R&S Order No.	C	R&S Order No.
20 Hz	24.0 kΩ	RL 0084.3793.00	330 nF	CK 0008.1893.00
1 kHz	4.81 kΩ	RL 0084.2451.00	33 nF	CK 0007.7681.00
7 kHz	3.32 kΩ	RL 0084.2145.00	6.8 nF	CK 0007.7646.00
20 kHz	2.40 kΩ	RL 0083.9875.00	3.3 nF	CK 0007.7623.00

Notch frequency:

$$f_1 = \frac{1}{2\pi RC}$$

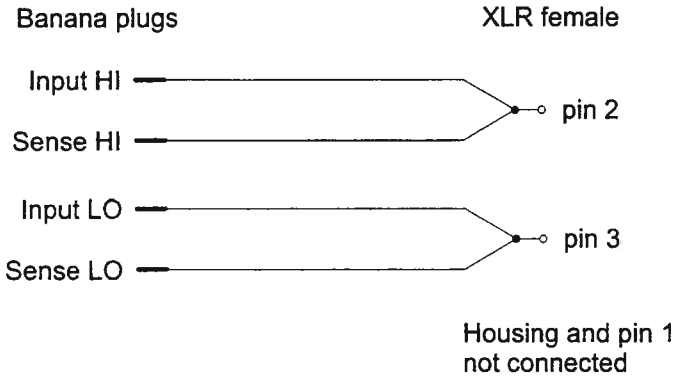
The attenuation $a_n = U_e/U_a$ of the notch filter for the harmonics $n * f_1$ of the fundamental f_1 must be taken into account with the THD measurement:

Frequency	Attenuation	a_n
f_1	>60 dB	—
$2 * f_1$	9.1 dB	2.85
$3 * f_1$	5.1 dB	1.80
$4 * f_1$	3.3 dB	1.50
$5 * f_1$	2.3 dB	1.30

Test cable for the measurement of the source resistance

Materials: XLR female cable connector
2 two-leaded cables
4 banana jacks

Construction:



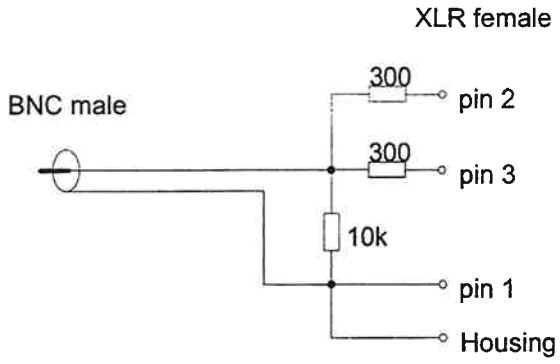
Test cable for the measurement of the output balance

Materials: XLR female cable connector, consisting of:
– Housing (Order name: NM3FXI, Neutrik)
– Cable outlet (Order name: CML, Neutrik)
BNC cable
10-kΩ-resistor (metal film, tolerance ±1 %)
2 matched 300-Ω-resistors

The two 300-Ω resistors must be matched to an accuracy of at least 0.01 % in order to achieve a measurement limit of < –90 dB. The absolute value is not important, but it should be in the range between 295 Ω and 305 Ω.

The two matched 300-Ω-resistors can be ordered with the order no. 0633.8289.00 as spare part from R&S, Zentralservice München ($\Delta R < 0.005$ %, $\Delta TK < 1$ ppm/K).

Construction: These three resistors must be installed in the XLR female cable connector.



Test cable for the measurement of the common mode rejection

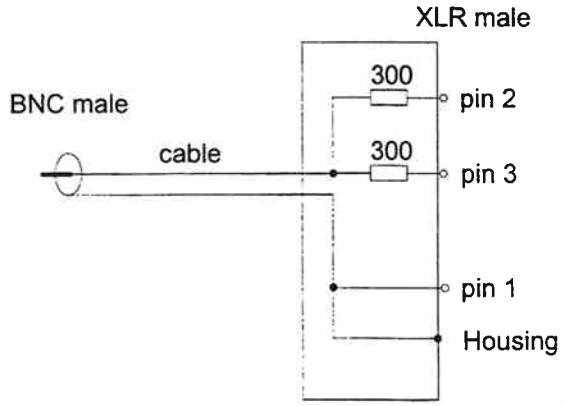
Materials: XLR male cable connector, consisting of: (on order)
- Housing (Order name: NM3MXI, Neutrik)
- Cable outlet (Order name: CML, Neutrik)

BNC cable
2 paired 300-Ω-resistors

The two 300-Ω resistors must be matched to an accuracy of at least 0.01 %. The absolute value is not important, but it should be in the range between 295 Ω and 305 Ω.

(order (2) 0633.2889.00) The two matched 300-Ω-resistors can be ordered with the order no. 0633.~~6289.00~~ as spare part from R&S, Zentralservice München ($\Delta R < 0.005$ %, $\Delta TK < 1$ ppm/K).

Construction: The 2 resistors are built in the XLR male cable connector.



Cable from XLR female to 2* banana jacks

Materials: symmetrical cable
2 banana jacks

Construction: Remove **male** connector from XLR cable.
Connect banana jack for Input HI with pin 2 of the XLR female connector.
Connect banana jack for Input LO with pin 3 of the XLR female connector.
The shielding is not connected.

NOTE: Instead of this cable the following adaptation can be used:
Adapter XLR/BNC, UPL-Z1, Order No. 1078.3704.02
+ BNC cable, commercially available
+ Adapter BNC female to 2*banana jacks, R&S Order No. FJ 0099.6687.00

Cable from XLR female connector to BNC male

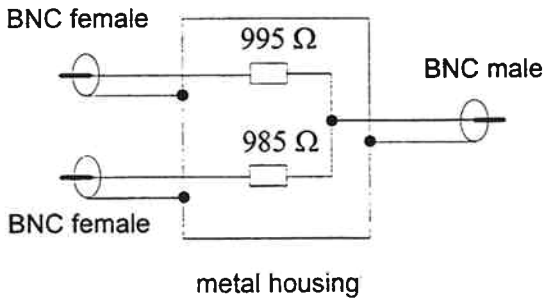
Materials: XLR female connector
BNC cable

Construction: Remove BNC connector on one side of the BNC cable.
Connect pin 2 of the XLR female connector with the inner conductor of the BNC cable.
Connect pin 3 of the XLR female connector with the shielding of the BNC cable.
Pin 1 and the case are not connected.

NOTE: Instead of this cable the XLR/BNC adapter UPL-Z1, Order No. 1078.3704.02, may be used.

Resistance Network RES NET 1

Curcuit Diagram and Construction:



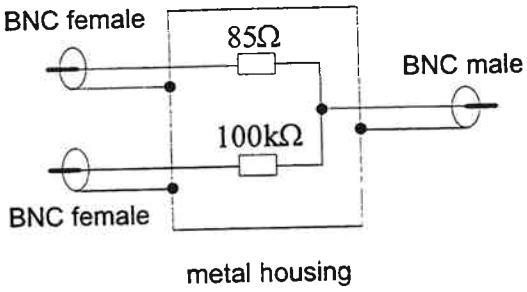
Materials: 3 BNC for case mounting
1 metal housing

Components:

Resistors (metal film)		
Value	Tolerance	R&S Order No.
995 Ω:	±0.1 %	
built in parallel from		
1 kΩ	±0.1 %	RL 0083.9146.00
66.5 kΩ	±0.1 %	RL 0084.4648.00
985 Ω	±0.1 %	
built in parallel from		
1 kΩ	±0.1 %	RL 0083.9146.00
200 kΩ	±1 %	RL 0083.2235.00

Resistance Network RES NET 2

Curcuit Diagram and Construction:



Materials: 3 BNC for case mounting
1 metal housing

Components:

Resistors (metal film)		
Value	Tolerance	R&S Order No.
85 Ω:	±0.1 %	
built in parallel from		
150 Ω	±0.1 %	RL 0083.7566.00
196 Ω	±0.1 %	RL 0084.0795.00
100 kΩ	±0.1 %	RL 0084.4983.00

2.2 Test Sequence

2.2.1 Performance Test Analog Generator

Adaptation of the measuring instruments to the generator output:

The output of the generator is XLR male. The balanced signal is applied between pin 2 and pin 3. The same is true for the unbalanced signal, however: pin 2 is HI, pin 3 is LO (corresponding to AES-14). The inputs of the digital multimeter are banana jacks, the input of the frequency counter is a BNC socket. Therefore, direct connection via a commercially available cable is not possible. The easiest way of adaptation is as follows:

- ▷ Retrofit the outputs of the generator to BNC female using UPL-Z1 (XLR/BNC adapter set).
- ▷ Retrofit the input of the digital multimeter to BNC female using an adapter BNC female to 2∗banana plug.
- ▷ Commercially available BNC cables can then be used for further connections.

As an alternative, special cables XLR female to 2∗banana plug and XLR female to BNC female can be manufactured. The configuration of such cables is described in section 2.1, starting at page 2.8.

Before starting the test, set the UPL to a defined initial status.
To this end, call the default setting in the FILE Panel under the menu item
`LOAD INSTRUMENT STATE → Mode → DEF SETUP.`

2.2.1.1 Sinewave Level Accuracy at 1kHz

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	2 ≡ 1
Output	UNBAL
FUNCTION	SINE
Low Dist	OFF
FREQUENCY	1.0000 kHz
VOLTAGE	*)

*) set according to test report

Measuring instrument:
AC voltmeter

Measurement: Connect AC voltmeter to output of UPL generator.
To this end, use an adapter XLR female to 2∗banana plug.
Further UPL setting and measurement according to test report.

NOTE:
This test is affected by the following adjustments:
→ Level adjustment analog generator
→ LF adjustment lowpass 23 kHz

2.2.1.2 Sinewave Frequency Response

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	SINE
Low Dist	OFF
FREQUENCY	*)
VOLTAGE	*)

*) set according to test report

Measuring instrument:

AC voltmeter

Measurement: Connect AC voltmeter to output of UPL generator.
To this end, an adapter XLR female to 2*banana plug is required.
Relative display in dB, reference is the voltage measured at 1 kHz.
Further UPL setting and measurement according to test report.

NOTE:
This test is affected by the following adjustments:
→ LF adjustment lowpass 23 kHz
→ 20-kHz adjustment lowpass 23 kHz

2.2.1.3 Sinewave Frequency Accuracy

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	SINE
Low Dist	OFF
FREQUENCY	1.0000 kHz
VOLTAGE	1.0000 V

Measuring instrument:

Frequency counter

Measurement: Connect frequency counter to output of UPL generator.
To this end, an adapter XLR female to BNC female is required.

2.2.1.4 DC Offset 0 V: Offset Error

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	SINE
Low Dist	OFF
DC Offset	ON
	0.0000 V
FREQUENCY	1.0000 kHz
VOLTAGE	*)

*) set according to test report

Measuring instrument:
DC voltmeter

Test setup: Connect DC voltmeter to output of UPL generator.
To this end, an adapter XLR female to 2*banana plug is required.

CAUTION:
The diagnostic mode is used for the following measurements (see also section 3.3.1.1, page 3.12). The diagnostic mode permits extensive interventions in the UPL hardware. Therefore, perform the following settings very carefully and avoid faulty inputs.

Measurement: To enable measurement of the small DC offset, the AC level of the generator must be switched off. In order not to change the setting of the generator hardware, the AC level of the D/A converter for signal generation is switched off. To this end, diagnostic mode is used:

1. Enter the Diagnostic password 1.4142 in the OPTIONS panel.
2. Open diagnostic mode: Diag State → ON.
3. Set the AC voltage according to the test report on the UPL.
4. Switch off the AC level in diagnostic mode: DAC VoltAC → 0.
5. Measure the DC voltage using the DC voltmeter.
6. Continue with 3. until the measurement sequence is finished.
7. Quit diagnostic mode: Diag State → OFF.

NOTE:
This test is affected by the following adjustment:
→ DC-offset adjustment

2.2.1.5 DC Offset: Setting Error

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	SINE
Low Dist	OFF
DC Offset	ON, *)
FREQUENCY	1.0000 kHz
VOLTAGE	0.0000 V

*) set according to test report

Measuring instrument:
DC voltmeter

Measurement: Connect DC voltmeter to output of UPL generator and measure the DC voltage at the output of the UPL generator.
To this end, an adapter XLR female to 2*banana plug is required.
Further UPL setting and measurement according to test report.

NOTE:
This test is affected by the following adjustment:
→ Level adjustment analog generator
→ DC-offset adjustment

2.2.1.6 THD+N Inherent Distortion

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	SINE
Low Dist	OFF
FREQUENCY	*)
VOLTAGE	*)

*) set according to test report

Measuring instrument:
Analyzer for THD+N: UPD

Setting of the UPD analyzer for:

22 kHz test bandwidth	
Analyzer	
INSTRUMENT	ANLG 22kHz
Channel(s)	1
Ch1 Input	*)
Ch1 Range	AUTO
FUNCTION	THD+N/SINAD
Dyn Mode	PRECISION
Unit	dB
FrqLim Low	20.00 Hz
FrqLim Upp	21.90 kHz

100 kHz test bandwidth	
Analyzer	
INSTRUMENT	ANLG 100kHz
Channel(s)	1
Ch1 Input	*)
Ch1 Range	AUTO
FUNCTION	THD+N/SINAD
Dyn Mode	PRECISION
Unit	dB
FrqLim low	150.00 Hz
FrqLim upp	100.00 kHz

*) set according to UPL generator Output,
Input BAL with impedance 20 kΩ.

Test setup Connect UPD analyzer to output of UPL generator
Output BAL: Use balanced cable (XLR).
Output UNBAL: Use adapter XLR female to BNC female and an unbalanced cable (BNC).

Measurement: Further UPL setting and measurement according to test report.

2.2.1.7 MOD DIST Inherent Distortion

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	MOD DIST
UPPER FREQ	*)
LOWER FREQ	60 Hz
VOLT LF:UF	4.0000 : 1
TOTAL VOLT	20.000 Vpp

*) set according to test report

Measuring instrument:
Analyzer for MOD DIST: UPD

Set UPD:

Analyzer	
INSTRUMENT	ANLG 22 kHz
Channel(s)	1
Ch1 Input	UNBAL BNC
Ch1 Range	AUTO
FUNCTION	MOD DIST
Dyn Mode	PRECISION
Unit	dB

Auxiliary means:

External RC highpass: HP MOD DIST

Test setup: Connect HP MOD DIST between output of UPL generator and input of UPD analyzer. To this end, an adapter XLR female to BNC female is required. The highpass eliminates the influence of the inherent distortions of the analyzer. The attenuation of the highpass in the passband does not affect the measurement.

Measurement: Further UPL setting and measurement according to test report.

2.2.1.8 DFD Level Accuracy

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	DFD
DC Offset	OFF
MEAN FREQ	*)
DIFF FREQ	425.00 Hz
TOTAL VOLT	1.0000V

*) set according to test report

Measuring instrument:

AC voltmeter

Measurement: Connect AC voltmeter to output of UPL generator.
To this end, an adapter XLR female to 2*banana plug is required.
Measure the RMS value of the output voltage of the UPL generator.
Furher UPL setting and measurement according to test report.

NOTE:
This test is affected by the following adjustment:
→ Level adjustment analog generator

2.2.1.9 DFD d2 Inherent Distortion

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	DFD
DC Offset	OFF
MEAN FREQ	*)
DIFF FREQ	425.00 Hz
TOTAL VOLT	5.0000V

*) set according to test report

Measuring instrument:

Selective voltmeter: UPD

Set UPD:

Analyzer	
INSTRUMENT	ANLG 22 kHz
Channel(s)	1
Ch1 Input	UNBAL BNC
Ch1 Range	AUTO
FUNCTION	RMS SELECT
Unit Ch1	dBr
Reference	VALUE:
	3.5000 V
Bandwidth	BP 3 %
FREQ MODE	FIX:
	425.00 Hz

Auxiliary means:

External RC lowpass: LP DFD

Measurement procedure:

- ▷ Connect the LP DFD between output of UPL generator and input of UPD analyzer. To this end, an adapter XLR female to BNC female is required.
- ▷ The lowpass eliminates the influence of the inherent distortions of the analyzer. The attenuation of the lowpass in the passband does affect the measurement and is taken into account in the reference value of the analyzer.
- ▷ Measure the RMS value of the voltage at the output of the lowpass selectively.
- ▷ The displayed measured value (in dBr) is the DFD d2 inherent distortion (in dB).

Measurement: Further UPL setting and measurement according to the test report

2.2.1.10 DFD d3 Inherent Distortion

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	DFD
DC Offset	OFF
MEAN FREQ	*)
DIFF FREQ	425.00 Hz
TOTAL VOLT	5.0000V

*) set according to test report

This is the same setting as the one used for the measurement of DFD d2.

Measuring instrument:

Analyzer for DFD d3: UPD

Set UPL:

Analyzer	
INSTRUMENT	ANLG 22 kHz
Channel(s)	1
Ch1 Input	UNBAL BNC
Ch1 Range	AUTO
FUNCTION	DFD
Meas Mode	d3 (IEC268)
Unit	dB

Measurement: Connect UPD analyzer to output of UPL generator.
To this end, an adapter XLR female to BNC female is required.
Further UPL setting and measurement according to test report.

2.2.1.11 Output Impedance

The output impedance R_{off} of the deactivated channel is measured using an ohmmeter.
The output impedance R_{on} of the activated channel is calculated from the voltage division with a known impedance, e.g. the impedance R_{off} of the deactivated channel measured before.

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	*)
Output	*)
Impedance	*)
FUNCTION	SINE
Low Dist	OFF
FREQUENCY	1.0000 kHz
VOLTAGE	1.0000 V

*) set according to test report

Measuring instruments:

Digital multimeter for impedance measurement (ohmmeter)
AC voltmeter

Test setup for the measurement of R_{off}:

Connect ohmmeter to output of UPL generator.
R_{off} must be measured directly at the output terminals of the UPL. In order to avoid errors in measurement due to lead resistances, it is recommended to perform the impedance measurement using the four-wire technique. The configuration of an appropriate cable is described in section 2.1, page 2.7.

Measurement:

- ▷ Set UPL generator according to test report.
- ▷ Measure the impedance R_{off} of the deactivated channel using the ohmmeter.

Test setup for the measurement of R_{on}:

- ▷ Retrofit both channels of the UPL generator to BNC female using UPL-Z1 (XLR/BNC Adapter).
- ▷ Connect possibly short BNC cables **of the same length** to both channels (if the cables are of the same length, their lead resistances cancel each other out in the formula for R_{on}.
- ▷ Connect both BNC cables using a BNC T-junction.
- ▷ Connect AC voltmeter to the BNC T-junction. To this end, an adapter BNC female to 2*banana plug and a BNC-BNC female junction is required.

Measurement:

- ▷ Set channel(s) and output of generator according to test report.
- ▷ Disconnect the BNC cable from the deactivated channel.
- ▷ Measure AC, note the measured value as U_1.
- ▷ Reconnect the deactivated channel.
- ▷ Measure AC, note the measured value as U_2 ($U_2 \approx 0.5 * U_1$).

Calculate the output impedance R_{on} according to the following formula:

$$R_{on} = \frac{1}{\frac{1}{R_{off}(\frac{U_1}{U_2} - 1)} - \frac{1}{R_{ac}}}$$

where R_{ac} = input impedance of the AC voltmeter
(neglectable if $R_{ac} > 1000 * R_{off}$)

If R_{ac} is neglectable, the formula for R_{on} is simplified as follows:

$$R_{on} = R_{off}(\frac{U_1}{U_2} - 1)$$

CAUTION:
For calculating R_{on} of **channel 1**, R_{off} of **channel 2** must used in the above formula and vice versa. R_{off} is known from the previous measurement.

2.2.1.12 Crosstalk

Due to the high crosstalk attenuation of typ. 120 dB a very small voltage of a few μV must be measured at the deactivated channel. For this purpose, a selective voltmeter as the one provided in the UPD analyzer, for example, is required.

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	*)
Output	*)
Impedance	*)
FUNCTION	SINE
Low Dist	OFF
FREQUENCY	20.000 kHz
VOLTAGE	10.00 V

*) set according to test report

Measuring instrument:
Selective voltmeter: UPD

Set UPD:

Analyzer	
INSTRUMENT	ANLG 22 kHz
Channel(s)	1
Ch1 Input	*)
Ch1 Range	AUTO
FUNCTION	RMS SELECT
Unit	dBr
Reference	VALUE:
	10.000 V
Bandwidth	BP 3 %
FREQ MODE	FIX:
	20.000 kHz

*) set according to UPL generator Output

Test setup: Connect UPD analyzer to output of UPL generator via a shielded cable.
Output BAL: use balanced cable (XLR).
Output UNBAL: Use an adapter XLR female to BNC female and an unbalanced cable (BNC).

Measurement:
- ▷ Setting of UPL generator according to test report.
- ▷ Selective RMS measurement on activated channel, a measured value of about 0 dBr (= 10 V) must be displayed.
- ▷ Switch generator to the other channel.
- ▷ Selective RMS measurement on the now deactivated channel. The measured value is the crosstalk.

2.2.1.13 Output Balance

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	*)
Output	BAL
Impedance	10 Ω
FUNCTION	SINE
Low Dist	OFF
FREQUENCY	*)
VOLTAGE	10.000 V

*) set according to test report

Measuring instrument:

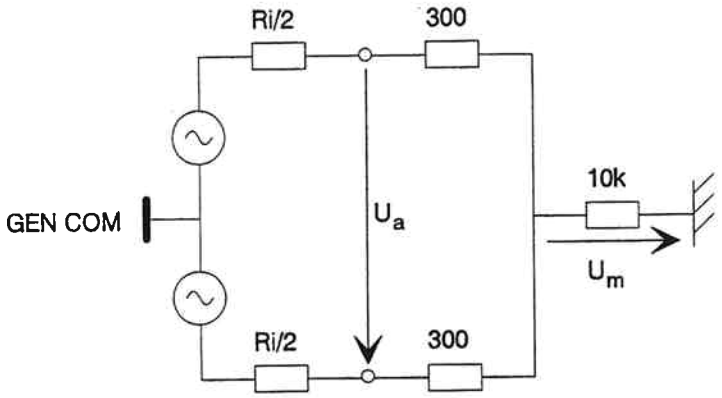
Selective voltmeter: UPD

Set UPD:

Analyzer	
INSTRUMENT	ANLG 22 kHz
Channel(s)	1
Ch1 Input	UNBAL BNC
Common	FLOAT
Ch1 Range	AUTO
FUNCTION	RMS SELECT
Unit	dBr
Reference	VALUE:
	10.00 V
Bandwidth	BP 3 %
FREQ MODE	FIX: *)

*) set according to frequency of UPL generator

Test setup:



The two 300-Ω resistors must be matched to an accuracy of at least 0.01 % in order to achieve a measurement limit of < –90 dB. The absolute value is not important, but it should lie in the range between 295 Ω and 305 Ω.

The three resistors must be installed in an XLR female cable connector. The signal U_m is supplied via a BNC cable and applied to the unbalanced input of the analyzer.

The configuration of an appropriate cable is described in section 2.1, page 2.7.

Measurement:

- ▷ Set UPL generator according to test report.
- ▷ Selective RMS measurement on the activated channel. The displayed measured value (in dBr) is negative.
- ▷ Enter the measured value with positive sign as output balance (with the unit dB) into the test report.

NOTE:
This test is affected by the following adjustment:
→ Adjustment of output balance.

2.2.2 Performance Test Analog Analyzer

Before starting the test, set the UPL to a defined initial status.
To this end, call the default setting in the FILE Panel under the menu item
`LOAD INSTRUMENT STATE → Mode → DEF SETUP`.
For testing the rated specifications of the UPL Analog Analyzer, it is recommended to proceed according to the following test procedure:

2.2.2.1 Level Measurement RMS

Set UPL:

Analyzer	
INSTRUMENT	ANLG 22kHz ANLG 110kHz *)
Channel(s)	2 ≡ 1
Impedance	200 kΩ
Range	FIX: *)
FUNCTION	RMS
Unit	*)

*) set according to test report

NOTE
The UPL analyzer is equipped with balanced (BAL) inputs for ranges from 18 mV to 30 V.
As quite a few internal range combinations are repeated, it is not necessary to measure all ranges (see also level table in section 1, page 4.3).
It is sufficient to test only the ranges 100 mV, 300 mV, 3 V, 6V and 30 V.

- Level accuracy at 1 kHz

  (see test report section 2.3.2, page 2.67)

  Measuring equipment:

  UPD generator: sinewave, Channel(s) 2 ≡ 1, Output BAL, Impedance 10 Ω, Common GROUND

  AC voltmeter

  Test setup: Connect AC voltmeter to an output of the UPD generator:
  to this end, use adapter BNC socket to 2* banana plug, adapter XLR plug to BNC socket and XLR cable.
  Connect the XLR input of the UPL to be tested to the other output of the UPD generator via an XLR cable.

  Measurement: Set generator and UPL analyzer according to test report. Input voltage U_e = 0.75 * rated range value!
  Measure the actual value of the input voltage using the AC voltmeter. Reference is the voltage measured at 1 kHz: → enter as reference for CH1 and CH2 in the analyzer panel. Read off the UPL display in dBr.

- Linearity at 20 kHz

  (see test report section 2.3.2, page 2.68)

  Measuring equipment:

  UPD generator: sinewave, Channel(s) 2 ≡ 1, Output BAL, Impedance 10 Ω, Common GROUND
  AC voltmeter

  Test setup: Connect AC voltmeter to an output of the UPD generator:
  to this end, use adapter BNC socket to 2* banana plug, adapter XLR plug to BNC socket and XLR cable.
  Connect the XLR input of the UPL to be tested to the other output of the UPD generator via an XLR cable.

  Measurement: Set generator and UPL analyzer and measure according to test report.
  Measure the actual value of the input voltage at 1 kHz using the AC voltmeter.
  Reference is the voltage measured at 1 kHz:
  → enter as reference for CH1 and CH2 in the analyzer panel.
  Read off the UPL display ΔU_0 in dBr for each channel.
  Repeat the procedure at the other frequencies.
  Read off the UPL display ΔU_x in dBr for each channel.
  The linearity error is obtained by forming the difference $\Delta U_x - \Delta U_0$ for each test value.

  Note: This test is used to ensure correct functioning of the UPL analyzer. The measurement results are no concrete data sheet values, but implicitly included in their error limits!

2.2.2.2 Frequency response

(see test report section 2.3.2, page 2.69)

UPL einstellen:

Analyzer	
INSTRUMENT	ANLG 22kHz ANLG 110kHz *)
Channel(s)	2 ≡ 1
Impedance	200 kΩ
Range	FIX: *)
FUNCTION	RMS
Unit	dBr

*) set according to test report

Measuring equipment:

UPD generator: sinewave, Channel(s) $2 \equiv 1$, Output BAL, Impedance 10 Ω, Common GROUND
AC voltmeter

Test setup: Connect AC voltmeter to an output of the UPD generator:
to this end, use adapter BNC socket to 2 * banana plug, adapter XLR plug to BNC socket and XLR cable.
Connect the XLR input of the UPL to be tested to the other output of the UPD generator via an XLR cable.

Measurement: Set generator and UPL analyzer and measure according to test report.
Input voltage $U_e = 0.75 *$ nominal voltage of range!
Measure the actual value of the input voltage 1 V at 20 kHz using the AC voltmeter.
Reference is the voltage measured at 1 V:
→ enter as reference for CH1 and CH2 in the analyzer panel.
Read off the UPL display ΔU_0 in dBr for each channel.
Repeat the procedure for the other voltages.
Read off the UPL display ΔU_x in dBr for each channel.
Form the difference $\Delta U_x - \Delta U_0$ for each test value.

2.2.2.3 Inherent Noise

(see test report section 2.3.2, page 2.74)

Set UPL:

Analyzer	
Instrument	ANLG 22kHz ANLG 110kHz *)
Channel(s)	2 ≡ 1
Impedance	300 Ω
Range	FIX: 18 mV or AUTO
Function	RMS/QPEAK *)
Unit	V
Filter	*)

*) set according to test report

Test setup: UPL without input terminals

Measurement: Set UPL analyzer and measure according to test report.

2.2.2.4 Input Impedances

(see test report section 2.3.2, page2.75)

Set UPL:

Analyzer	
Channel(s)	2 ≡ 1
Impedance	*)
Range	FIX: 30.0 V
Function	DC

*) set according to test report

Measuring instrument:

Digital multimeter for impedance measurement

Measurement: Connect digital multimeter to the inputs of the UPL: to this end, use adapter BNC socket to banana plug, adapter XLR plug to BNC socket and XLR cable.
Set UPL analyzer and measure the input impedances according to the test report.

2.2.2.5 Crosstalk

(see test report section 2.3.2, page2.75)

Set UPL:

Analyzer	
Instrument	ANLG 22kHz
Channel(s)	2 & 1
Impedance	600 Ω (channel without signal) *)
Function	RMS SELECT
Unit	dBr
Freq Mode	FIX: 20kHz

*) set according to test report

Measuring instrument:

UPD generator: sinewave, 10 V, 20 kHz, Channel(s) 2 ≡ 1, Output BAL, Impedance 10 Ω, Common GROUND

Test setup: Connect one XLR input of the UPL to one output of the UPD generator via an XLR cable. No signal is applied to the other input channel, which must be internally terminated with 600 Ω.

Measurement: Set UPL analyzer according to test report.

Store the measured value of the supplied channel as reference value. → Reference STORE CH1 or 2
The measured value of the other channel shows the crosstalk. (crosstalk attenuation with opposite sign!)
Check crosstalk of channel 1 — 2 and channel 2 → 1.

Note: Due to the high crosstalk attenuation of typ. 140dB a very small voltage of a few μV must be measured at the channel where no signal is applied.

2.2.2.6 Common-mode rejection

(see test report section 2.3.2, page 2.75)

Set UPL:

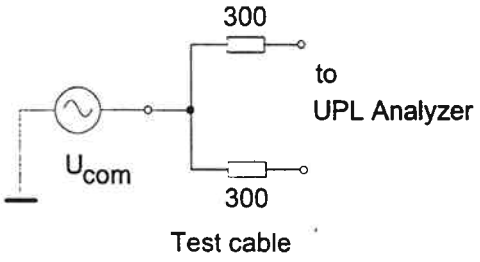
Analyzer	
Instrument	ANLG 22kHz
Channel(s)	2 ≡ 1
Impedance	200 kΩ
Range	FIX: *)
Function	RMS SELECT
Unit	dBr
Freq Mode	FIX: *)

*) Set respective generator frequency according to test report.

Measuring instrument:

UPD generator: sinewave, Channel(s) 2 ≡ 1, Output UNBAL, Impedance 5 Ω, Common GROUND

Test setup: Connect unbalanced output of UPD generator via BNC cable to Test cable for common-mode rejection and connect the latter to an XLR input of the UPL.



The two 300-Ω impedances must comply with each other with an accuracy of ±0.01 %. The absolute value is non-critical and should lie in the range from 295 to 305 Ω. (see section 2.1, page 2.8)

Measurement: Set UPL analyzer according to test report.
Store generator voltage as level reference value in the analyzer panel. → Reference STORE CH1 or 2
The measured value of the supplied channel shows the output balance with opposite sign.

2.2.2.7 Frequency Measurement

(see test report section 2.3.2, page 2.76)

Set UPL:

Analyzer	
Instrument	ANLG 22kHz ANLG 110kHz *)
Channel(s)	2 ≡ 1
Input	BAL
Impedance	200 kΩ
Range	FIX: 1.0 V
FREQ/PHASE	FREQ
Meas Time	250 ms
Unit	f/fr

*) set according to test report

Measuring equipment:

UPD Generator:
Frequency counter

Test setup: Connect frequency counter to an output of the UPD generator: to this end, use BNC cable, adapter XLR socket to BNC.
Connect the XLR input of the UPL to be tested to the other output of the UPD generator via an XLR cable.

Measurement: Set UPD-Generator and UPL analyzer according to test report.
Additional UPL setting: frequency display 6-digit →OPTIONS panel: → DISPLAY Read Resol CHOICE...
Measure generator frequency using frequency counter and store as frequency reference value in the analyzer panel: → Reference Value
The relative frequency display of the UPL shows the ratio between actual and nominal value.
The offset in ppm results from $(actualvalue/nominalvalue - 1) * 10^6$.

2.2.2.8 Phase Measurement

(see test report section 2.3.2, page 2.77)

Set UPL:

Analyzer	
Channel(s)	2 ≡ 1
Range	FIX: *)
FREQ/PHASE	PHASE
Unit	°

*) set according to test report

Measuring equipment:

UPD generator: sinewave 20 Hz – 22 kHz, Channel(s) 2 ≡ 1, Output BAL, Impedance 10 Ω.

Test setup: Connect the two outputs of the UPD generator to the two inputs of the UPL analyzer via XLR cable.

Measurement: Set generator and UPL analyzer and measure according to test report.
Input voltage U_e = 0.75 * rated range value!
Read off the UPL phase difference display.

Note: This test only refers to the phase coincidence of the 2 channels. Thus proper functioning of the UPL hardware is ensured. The actual measuring accuracy of the phase is not tested — it is determined by the algorithm of the UPL program (type acceptance test performed in the factory!).

2.2.2.9 DC Measurement

Set UPL:

Analyzer	
INSTRUMENT	ANLG 22kHz ANLG 110kHz *)
Channel(s)	2 ≡ 1
Impedance	*)
Range	FIX: *)
FUNCTION	DC
Unit	*)

*) set according to test report

The UPL analyzer is equipped with balanced (BAL) inputs for ranges from 100 mV to 30 V.
As quite a few internal range combinations are repeated, it is not necessary to measure all ranges (see also level table in section 1, page 4.3).
It is sufficient to test only the ranges 100 mV, 300 mV, 1 V, 3 V, 10 V and 30 V.

- DC offset

  (see test report section 2.3.2, page 2.78)

  Measurement: Set UPL analyzer according to test report.
  Internally terminate the inputs with low impedance → Impedance 300 Ω; no signal applied!
  Read off the actual value from the UPL display.

- DC measuring accuracy

  (see test report section 2.3.2, page 2.78)

Measuring equipment:

UPD generator: DC offset, Channel(s) 2 ≡ 1, Output BAL, Impedance 10 Ω, Common GROUND.
DC voltmeter

Test setup: Connect DC voltmeter to an output of the UPD generator: to this end, use adapter BNC socket to banana plug, adapter XLR plug to BNC socket and XLR cable.
Connect the XLR input of the UPL to be tested to the other output of the UPD generator via an XLR cable.

Measurement: Set UPD generator and UPL analyzer (→ Impedance 200 kΩ) and measure according to test report.
Measure the actual value of the input voltage using the DC voltmeter.
Reference is the measured voltage: → enter as reference for CH1 and CH2 in the analyzer panel.
Read off the UPL display ΔU in % for each channel.

Note: This is a stringent test for ensuring correct functioning of the UPL analyzer. The measurement results are no concrete data sheet values, but implicitly included in their error limits!

2.2.2.10 Distortion Factor THD

Set UPL:

Analyzer	
INSTRUMENT	ANLG 22kHz ANLG 110kHz *)
Channel(s)	2 ≡ 1
Impedance	200 kΩ
Range	FIX: *)
FUNCTION	THD

*) set according to test report

- Measuring accuracy THD ≥ –60 dB (see test report section 2.3.2, page 2.80)

Measuring equipment:

UPD generator: Channel(s) 2 ≡ 1, Output BAL, Impedance 10 Ω, Common GROUND, Low Dist OFF

Note: The UPD generator generates the complete signal with multisine: Fundamental and one harmonic with different level

Test setup: Connect the XLR input of the UPL to be tested to the output of the UPD generator via XLR cable.

Measurement: Set UPD generator and UPL analyzer according to test report.
Additional UPL analyzer setting:
THD → Meas Mode → SELECT di → d2
Read off the UPL-THD display in dB.

- Measuring accuracy THD < –60 dB (see test report section 2.3.2, page 2.80)

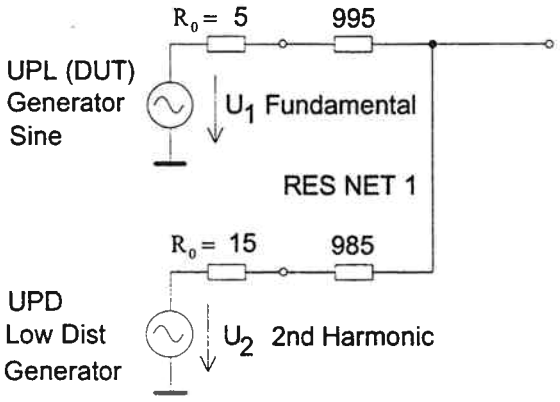
NOTE:

This test assumes that the analog generator of the UPL has been calibrated with respect to level and frequency.

Measuring equipment:

UPD Low Distortion Generator
UPL generator (DUT)
Resistance network with 985 Ω and 995 Ω

Signal generation:



Fundamental: → UPL generator (DUT).
Setting: Output UNBAL, Low Dist OFF, FREQUENCY → fundamental, VOLTAGE → 4 V
Harmonic: → from the UPD low distortion generator, a sinewave signal is added with 0 dB attenuation.
Setting: Output UNBAL, Impedance 15 Ω, Common GROUND FREQUENCY → harmonic $d2 = 2{*}f_{GenUPL}$, Setting PRECISION, VOLTAGE → Level d2 in dBr, Ref Volt → 4 V = Reference fundamental

Test setup: Connect the XLR input of the UPL to be tested via adapter XLR plug/BNC to the resistance network and connect the latter to the outputs of the two generators via BNC cable.

Measurement: Set generators and UPL analyzer and measure according to test report.
Additional UPL analyzer setting:
Range FIX 3 V, THD → Meas Mode → SELECT di → d2
Read off the THD-d2 display in dB:
Worst case out of 5 measurements is test result.

- Notch filter frequency response

(see test report section 2.3.2, page 2.81)

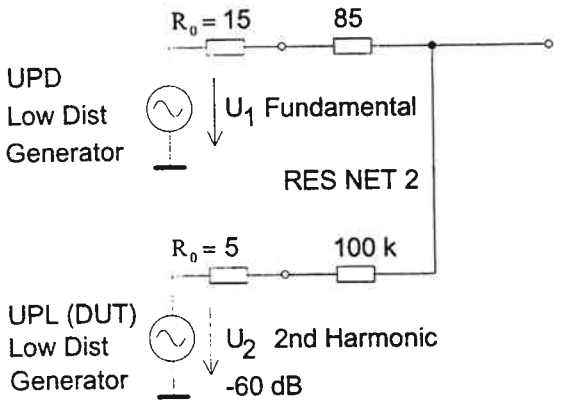
NOTE

This test assumes that the low distortion generator of the UPL has been calibrated with respect to level and frequency.

Measuring equipment:

UPD Low Distortion Generator
UPL Low Distortion Generator (DUT)
frequency counter
Resistance network with 85 Ω and 100 kΩ

Signal generation:



Fundamental: → UPD Low Distortion Generator .
Setting: Output UNBAL, Impedance 15 Ω, Common GROUND FREQUENCY → fundamental, Setting PRECISION, VOLTAGE → 2 V
Harmonic: → from the UPL generator (DUT), a sinewave signal with an attenuation of 60 dB is added.
Setting: Output UNBAL
FREQUENCY → harmonics $d2 = 2{*}f_{GenUPL}$,
VOLTAGE → level d2 = 0 dBr, Ref Volt → 2 V = Reference fundamental

Test setup: Connect the XLR input of the UPL to be tested via adapter XLR plug/BNC to the resistance network and connect the latter to the outputs of the two generators (to this end, use BNC cable for UPD generator; adapter XLR socket to BNC socket and BNC cable for UPL generator).
Connect the frequency counter to the other output of the UPL generator (to this end, use BNC cable and adapter XLR socket to BNC socket).

Measurement: Set generators and UPL analyzer and measure according to test report.
Measure the frequency of the harmonic d2 of the UPL generator using the frequency counter.
→ f_{d2}
Additional UPL analyzer setting:
INSTRUMENT ANLG 110kHz, Range FIX 3 V,
THD Meas Mode → SELECT di → d2
Enter in the analyzer panel for
THD Fundamentl → VALUE = (testfrequency f_{d2})/2.
Read off the THD-d2 display in dB. Form the difference to the nominal value –60 dB.

- Inherent distortion THD

  (see test report section 2.3.2, page 2.81)

  NOTE

  This test only makes sense if the THD measuring accuracy has been calibrated before, confirming proper functioning of the internal analog notch filters and the postamplification factors (see pages 2.30 and 2.32).

  Measuring equipment:

  UPD Low Distortion Generator: Output BAL, Impedance 30 Ω
  Common GROUND,
  FREQUENCY Setting PRECISION

  Test setup: Connect the XLR input of the UPL to be tested to the output of the UPD generator via an XLR cable.

  Measurement: Set UPD generator and UPL analyzer and measure according to test report.
  Additional UPL analyzer setting:
  THD → Meas Mode → All di
  Read off the UPL THD display in dB

2.2.2.11 THD Inherent Distortion, Loop Generator-Analyzer

(see test report section 2.3.2, page 2.86)

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	2 ≡ 1
Output	*)
FUNCTION	SINE
Low Dist	ON
FREQUENCY	*)
VOLTAGE	*)

*) set according to test report

Measuring instrument:

Analyzer for THD: UPL (DUT)

Setting of UPL analyzer for:

22 kHz test bandwidth	
Analyzer	
INSTRUMENT	ANLG 22kHz
Channel(s)	2 ≡ 1
Input	GEN CROSSED
Range	AUTO
FUNCTION	THD
Meas Mode	All di
Dyn Mode	PRECISION
Unit	dB

100 kHz test bandwidth	
Analyzer	
INSTRUMENT	ANLG 110kHz
Channel(s)	2 ≡ 1
Input	GEN CROSSED
Range	AUTO
FUNCTION	THD
Meas Mode	All di
Dyn Mode	PRECISION
Unit	dB

NOTE:
The analyzer of the device under test must be used for this measurement, since the specifications in the data sheet apply to the sum inherent distortion of analyzer and generator.

Measurement: Further UPL setting and measurement according to test report.

2.2.2.12 Distortion Factor THD+N

(see test report section 2.3.2, page 2.86)
NOTE: This test only makes sense if the THD measuring accuracy has been calibrated before, confirming proper functioning of the internal analog notch filters and the postamplification factors. (see section 2.2.2.10, page 2.30 and 2.32).

Set UPL:

Analyzer	
INSTRUMENT	ANLG 22kHz *)
	ANLG 110kHz *)
Channel(s)	2 ≡ 1
Impedance	200 kΩ
Range	FIX: *)
FUNCTION	THD+N/SINAD
FrqLim low	*)
FrqLim upp	*)

*) set according to test report

- Inherent distortion THD+N, Analyzer

Measuring equipment:

UPD generator: Channel(s) 2 ≡ 1, Output BAL, Impedance 30 Ω, Common GROUND, Low Dist ON

Test setup: Connect the XLR input of the UPL to be tested to the output of the UPD generator via an XLR cable.

Measurement: Set UPD generator and UPL analyzer according to test report. Read off the UPL THD+N display in dB.

2.2.2.13 THD+N Inherent Distortion, Loop Generator–Analyzer

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	2 ≡ 1
Output	*)
FUNCTION	SINE
Low Dist	ON
FREQUENCY	*)
VOLTAGE	*)

*) set according to test report

Measuring instrument:

Analyzer for THD+N: UPL (DUT)

Setting of UPL analyzer for:

22 kHz test bandwidth	
Analyzer	
INSTRUMENT	ANLG 22kHz
Channel(s)	2 ≡ 1
Input	GEN CROSSED
Range	AUTO
FUNCTION	THD+N/SINAD
Dyn Mode	PRECISION
Unit	dB
FrqLim Low	20.00 Hz
FrqLim Upp	21.90 kHz

100 kHz test bandwidth	
Analyzer	
INSTRUMENT	ANLG 110kHz
Channel(s)	2 ≡ 1
Input	GEN CROSSED
Range	AUTO
FUNCTION	THD+N/SINAD
Dyn Mode	PRECISION
Unit	dB
FrqLim low	150.00 Hz
FrqLim upp	100.00 kHz

NOTE:
The analyzer of the device under test must be used for this measurement, since the specifications in the data sheet apply to the sum inherent distortion of analyzer and generator.

Measurement: Further UPL setting and measurement according to test report.

2.2.2.14 Modulation factor MOD DIST

Set UPL:

Analyzer	
INSTRUMENT	ANLG 22kHz *)
Channel(s)	2 ≡ 1
Impedance	200 kΩ
Range	FIX: *)
FUNCTION	MOD DIST

*) set according to test report

- Measuring accuracy MOD DIST < –60 dB

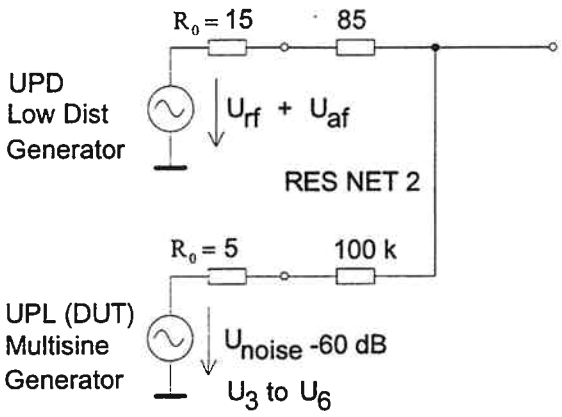
  (see test report section 2.3.2, page 2.91)

  NOTE: This test assumes that the analog generator of the UPL has been calibrated with respect to level and frequency.

  Measuring equipment:

  UPD Low Distortion Generator
  UPL generator (DUT):
  Resistance network with 85 Ω and 100 kΩ

Signal generation:



Mod Dist signal: → from UPD Low Distortion Generator
Setting: Output UNBAL, Impedance 15 Ω, Common GROUND
Low Dist ON, FUNCTION MOD DIST,
FREQUENCY → f_{rf} and f_{af}
Setting PRECISION
VOLTAGE → according to measurement instruction and test report.
Modulation lines: → UPL generator (DUT).
Setting: Output UNBAL, FUNCTION MULTISINE
FREQUENCY and VOLTAGE → according to table and formula.

No. of Sine	Frequency	Level
1	f_{af}	–140 dBr
2	f_{rf}	–140 dBr
3	f_{rf} - 2*f_{af}	U_3
4	f_{rf} - f_{af}	U_4
5	f_{rf} + f_{af}	U_5
6	f_{rf} + 2*f_{af}	U_6

$U_3 \ldots U_6$ in dBr
Reference for dBr is the level of f_{rf} → RefVolt = U_{rf}
U_{rf} = 0.7 V → U_{eff} = 4.1231*U_{rf} = 2.886 V (without spurious modulation)

Test setup: Connect the XLR input of the UPL to be tested via adapter XLR plug /BNC to the resistance adapter and connect the latter via BNC cable to the outputs of the two generators (to this end, use BNC cable for UPD generator; adapter XLR socket to BNC socket and BNC cable for UPL generator).

Measurement: Set generators and UPL analyzer and measure according to test report.

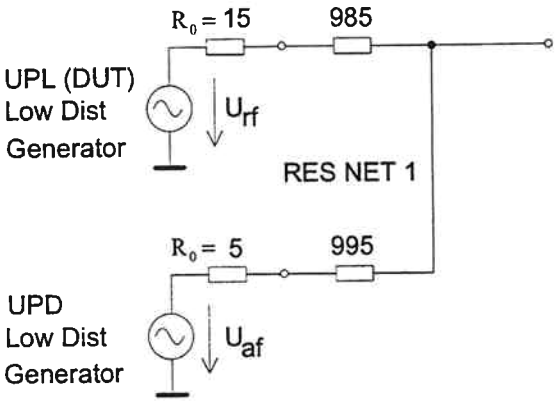
- Inherent distortion MOD DIST

(see test report section 2.3.2, page 2.92) NOTE: This test assumes that the generator of the UPL has been calibrated with respect to level and frequency.

Measuring equipment:

UPD Low Distortion Generator
UPL Low Distortion Generator (DUT)
Resistance network with 985 Ω and 995 Ω

Signal generation:



Sinewave U_{rf}: → from UPD Low Distortion Generator
Setting: Instrument ANLG 110kHz, Output UNBAL, Impedance 15 Ω, Common FLOAT, Low Dist ON, FUNCTION SINE, FREQUENCY → f_{rf}, Setting PRECISION
VOLTAGE → according to measurement instruction and test report.
Sinewave U_{af}: → UPL Low Distortion Generator (DUT).
Setting: Output UNBAL, FUNCTION SINE,
FREQUENCY and VOLTAGE → according to formula and test report.
RMS value of the complete signal at the output of the resistance network $U_a = U_{rms}$ from U_{rf} and U_{af}. The ratio U_{af}/U_{rf} is 4:1. Set this ratio via the generator levels.

$$U_{rf} = \left[\frac{U_{eff}}{\sqrt{2}}\right] \text{ and}$$

$$U_{af} = \left[\frac{4*U_{eff}}{\sqrt{4.25}}\right]$$

Test setup: Connect the XLR input of the UPL to be tested via adapter XLR plug /BNC to the resistance network and connect the latter to the outputs of the two generators (to this end, use BNC cable for UPD generator; adapter XLR socket to BNC socket and BNC cable for UPL generator).

Measurement: Set generators and UPL analyzer and measure according to test report.
Set generator voltage, set frequency f_{rf}, vary frequency f_{af}
→ set new f_{rf}, vary f_{af}
→ set the next voltage
Read off the MOD DIST display in dB.

2.2.2.15 Difference-tone Factor DFD

Set UPD:

Analyzer	
INSTRUMENT	ANLG 22kHz
Channel(s)	2 ≡ 1
Impedance	200 kΩ
Range	FIX: *)
FUNCTION	DFD
Meas Mode	*)

*) set according to test report

- Measuring accuracy DFD d2 and d3
  (see test report section 2.3.2, page 2.95)

Measuring equipment:

UPD generator

Signal generation:

UPD generator generates the complete signal with multisine
Setting: Output BAL, Impedance 30 Ω, Common FLOAT,
Function MULTISINE, Low Dist OFF
FREQUENCY and VOLTAGE → according to table and formula.

No. of Sine	Frequency	Level
1	f_1	–6 dBr
2	f_2	–6 dBr
3	f_3 = DiffFreq	U_3
4	$f_4 = f_1 - f_3$	U_4
5	$f_4 = f_1 + f_3$	U_5

f_1 = MeanFreq - DiffFreq/2
f_2 = MeanFreq + DiffFreq/2
$U_3 \ldots U_5$ in dBr
Reference for dBr is the level Ref Volt in the generator panel

Test setup: Connect the XLR input of the UPL to be tested to the output of the UPD generator via XLR cable.

Measurement: Set generators and UPL analyzer and measure according to test report.
For checking the measuring accuracies DFD d2 and d3, set the analyzer to Range Fix 3 V and the measurement function to be tested, the generator to Ref Volt = 2 V and $U_4 = U_5 = -140$ dBr.
Read off the display DFD d2 and d3, respectively, in dB.

- Inherent distortion DFD

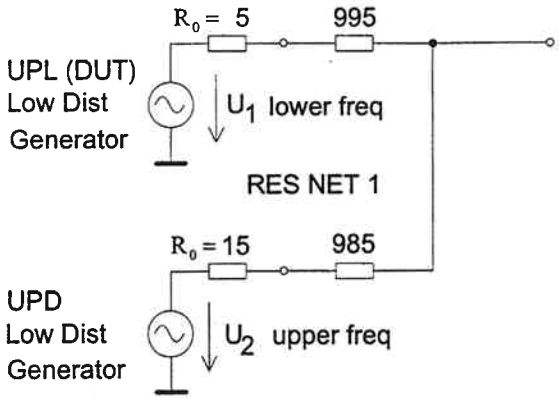
  (see test report section 2.3.2, page 2.97)

  NOTE: This test assumes that the generator of the UPL has been calibrated with respect to level and frequency.

  Measuring equipment:

  UPL Low Distortion Generator (DUT)
  UPD Low Distortion Generator
  Frequency counter
  Resistance network with 995 Ω and 985 Ω

Signal generation:



Sinewave U_1: → UPL Low Distortion Generator (DUT).
Setting: Output UNBAL, FUNCTION SINE
FREQUENCY → f_2
Sinewave U_2: → from UPD Low Distortion Generator
Setting: Output UNBAL, Impedance 15 Ω, Common FLOAT,
Low Dist ON, FUNCTION SINE, FREQUENCY → f_2
Setting PRECISION
The following is true for the generated voltages and frequencies:
$U_1 = U_2$
MeanFreq = $0.5 * (f_1 + f_2)$ center frequency
f_1 = MeanFreq − DiffFreq/2
f_2 = MeanFreq + DiffFreq/2
The following is true for the complete signal U_a at the output of the resistance network:

RMS value = $0.7071 * U_1$
peak value = $1.4142 * U_1 = 2*$ peak value

Test setup: Connect the XLR input of the UPL to be tested via adapter XLR plug /BNC to the resistance network and connect the latter to the outputs of the two generators (to this end, use BNC cable for UPD generator, adapter XLR socket/BNC and BNC cable for the UPL generator). Connect a frequency counter to the second output of the UPL generator (to this end, use adapter XLR socket/BNC and BNC cable).

Measurement: Set generators and UPL analyzer and measure according to test report.
Set generator voltages $U_1 = U_2 = U_{rms}/2$ and mean frequency with f_1 and f_2.
Read off the display DFD d2 or d3, respectively, in dB.

Note: When setting the test frequency of the UPL Low Distortion Generator, there may be problems with the frequency accuracy. Therefore, a subsequent measurement must be carried out using a frequency counter and, if necessary, a correction is to be performed!

2.2.3 Performance Test UPL-B1, Low Distortion Generator

Adaptation of the measuring instruments to the output of the generator is described in the Performance Test of the analog generator in section 2.2.1, page 2.11.

Before starting the test, set the UPL to a defined initial status.
To this end, call the default setting in the FILE Panel under the menu item
`LOAD INSTRUMENT STATE → Mode → DEF SETUP.`

2.2.3.1 Level Accuracy at 1kHz

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	SINE
Low Dist	ON
FREQUENCY	1.0000 kHz
VOLTAGE	*)

*) set according to test report

Measuring instrument:
AC voltmeter

Measurement: Connect AC voltmeter to output of UPL generator.
To this end, an adapter XLR female to 2*banana plug is required.
Further UPL setting and measurement according to test report.

NOTE:
This test is affected by the following adjustments:
→ Level adjustment analog generator
→ LF adjustment lowpass 23 kHz
→ Automatic adjustment low distortion generator

2.2.3.2 Frequency Response

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	SINE
Low Dist	ON
FREQUENCY	*)
VOLTAGE	*)

*) set according to test report

Measuring instrument:

AC voltmeter

Measurement: Connect AC voltmeter to output of UPL generator.
To this end, an adapter XLR female to 2*banana plug is required.
Relative display in dB, reference is the voltage measured at 1 kHz.
Further UPL setting and measurement according to test report.

NOTE:
This test is affected by the following adjustment:
→ 100-kHz adjustment low distortion generator

2.2.3.3 Frequency Accuracy

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	SINE
Low Dist	ON
FREQUENCY	*)
VOLTAGE	1.0000 V

*) set according to test report

Measuring instrument:

Frequency counter

Measurement:

Connect frequency counter to output of UPL generator.
To this end, an adapter XLR female to BNC female is required.
Further UPL setting and measurement according to test report.

NOTE:
This test is affected by the following adjustment:

→ Automatic adjustment low distortion generator

2.2.3.4 THD Inherent Distortion

Measurement procedure:

In the audio frequency range, the harmonics suppression of the UPL generator is typ. 115 dB to 125 dB, depending on the set frequency. The UPL analyzer features about the same harmonics suppression so that the inherent distortions of the generator cannot be directly checked using the UPL analyzer; the UPD analyzer or another analyzer available on the market cannot be used either. With the measurement function FFT, the UPD analyzer features a dynamic range of >100 dB. For measuring the harmonics suppression of the UPL generator, a passive notch filter is used, suppressing the fundamental by more than 60 dB, but attenuating the harmonics by less than 10 dB. This results in an increase of the dynamic range by 50 dB from 100 dB to 150 dB, referred to the non-suppressed fundamental. The attenuation of the harmonics by the notch filter must be taken into account in the measurement. The attenuation factors are indicated with the circuit of the notch filter, see section 2.1, page 2.6.
The measurement is performed at the frequencies 20 Hz, 1 kHz, 7 kHz and 20 kHz with a level of 2.5 V and 10 V.
The following example describes the setting of the UPL generator, of the UPD analyzer and the measurement procedure for a signal frequency of 1 kHz with a level of 2.5 V. The deviating settings of the UPD at the frequencies 20 Hz, 7 kHz and 20 kHz are listed subsequently.

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	UNBAL
FUNCTION	SINE
Low Dist	ON
FREQUENCY	*)
VOLTAGE	*)

*) set according to test report (in this example 1 kHz, 2.5 V).

Measuring instrument:

FFT analyzer: UPD

Setting of the UPD analyzer for a signal frequency of 1 kHz:

Analyzer	
INSTRUMENT	ANLG 22kHz
Channel(s)	1
Ch1 Input	UNBAL BNC
Common	FLOAT
Ch1 Range	AUTO
FUNCTION	FFT
Unit Ch1	dBr
Reference	VALUE: *)
FFT Size	8192
Window	RIFE VINC 2
Avg Mode	EXPONENTIAL
Avg Count	1
Zooming	OFF

Display	
OPERATION	SPECTRUM
TRACE A	FUNC CH1
Unit	V
Scale	MANUAL
Spacing	LOG
Top	100.00 μV
Bottom	0.0100 μV
X AXIS	FREQ
Scale	MANUAL
Spacing	LIN
Left	0.0000 Hz
Right	10.000 kHz

*) set according to generator voltage (in this example 2.5 V).

Test setup:

- ▷ Connect output of UPL generator to input of UPD analyzer. To this end, an adapter XLR female to BNC female is required.

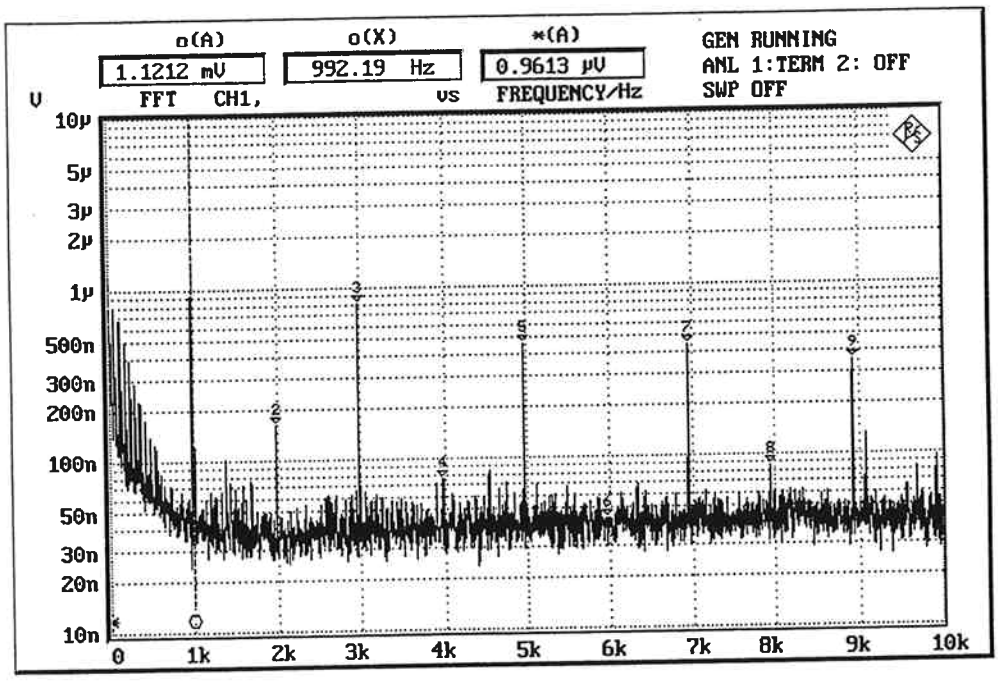
Preparation of the measurement:

- ▷ Press the [START] key to restart the measurement.
- ▷ The measured value displayed under RMS via FFT must be about 0 dBr.
- ▷ Connect the notch filter between the output of the UPL generator and the input of the UPD analyzer.
- ▷ In order to achieve a suppression of the fundamental of more than 60 dB it may be necessary to slightly readjust the generator frequency until the measured value RMS via FFT is < –60 dBr.

Measurement:

- ▷ Set Avg Count 8 in the Analyzer panel.
- ▷ Press the [GRAPH] key to change to full-screen graphics display.
- ▷ Press the [SINGLE] key to terminate the measurement. This is indicated by means of ANL 1:TERM 2: OFF in the second status line at the top right of the screen.
- ▷ For operating the graphics functions, the softkeys at the lower edge of the screen are used. If the lefthand softkey is labelled [BACK], press it twice to return to the main menu.
- ▷ Softkeys: [MARKER] → [TRACE A] → [MAX] → [HARM].
  The harmonics d_2 to d_9 are now marked by small triangles with numbers from 2 to 9.
- ▷ Softkeys: [BACK] → [BACK] → [o CURSOR] → [SET TO] → [MARKER].
  The o CURSOR is positioned at the fundamental (about 1 kHz).

Approximately the following picture should be displayed now:



▷ Press the softkey NEXT HARM. The cursor jumps to the next harmonic d_2. The voltage of this harmonic is displayed in the display field below o(A).

▷ Measure the voltage of each harmonic d_n (n = 2 to 5) using the cursor ($\rightarrow U_{dn}$) and correct with the attenuation a_n of the notch filter (the attenuations a_n are indicated with the circuit of the notch filter, see section 2.1, page 2.6). Thus the following voltage of the nth harmonic is obtained:

$$U_n = U_{dn} * a_n$$

▷ Calculation of the THD measurement result:
Squarelaw addition of the individual harmonics:

$$U_{THD} = \sqrt{\sum_{n=2}^{5} {U_n}^2}$$

Reference to the fundamental:

$$THD = 20 * \log \frac{U_{THD}}{U_1} \quad (in \quad dB)$$

where U_1 is the voltage set in the UPL generator (in this example 2.5 V).

Evaluation of the measurement for this example:

▷ Read off the values for U_{dn} in the above illustration. Multiplication by a_n results in the real value of the harmonics U_n.

n	U_{dn}	a_n	U_n
2	160 nV	2.85	0.456 μV
3	850 nV	1.8	1.530 μV
4	—	1.5	—
5	470 nV	1.3	0.611 μV
6	—	1.2	—
7	450 nV	1.16	0.522 μV

▷ The harmonics d_2 to d_5 are dominant.
The harmonics $> d_5$ can be neglected.

$$U_{THD} = \sqrt{\sum_{n=2}^{5} {U_n}^2} = 1.71\mu V$$

$$THD = 20 * \log \frac{U_{THD}}{U_1} = 20 * \log \frac{1.71\mu V}{2.5V} = -123.3dB$$

▷ If, in addition, d_7 with $U_n = 0.522\mu V$ was taken into account, the following would result:

$$U_{THD} = 1.79\mu V$$

and thus

$$THD = 20 * \log \frac{1.79\mu V}{2.5V} = -122.9dB$$

Setting of the UPD analyzer for other frequencies:

20 Hz

Analyzer	
INSTRUMENT	ANLG 22kHz
ZOOMING	ON (2..256)
Center	1 kHz
Span	5.48 kHz

Display	
OPERATION	SPECTRUM
X-AXIS	
Right	200.00 Hz

1 kHz

Analyzer	
INSTRUMENT	ANLG 22kHz
ZOOMING	OFF

Display	
OPERATION	SPECTRUM
X-AXIS	
Right	10.000 kHz

7 kHz

Analyzer	
INSTRUMENT	ANLG 100kHz
ZOOMING	OFF

Display	
OPERATION	SPECTRUM
X-AXIS	
Right	70.000 kHz

20 kHz

Analyzer	
INSTRUMENT	ANLG 300kHz
ZOOMING	OFF

Display	
OPERATION	SPECTRUM
X-AXIS	
Right	200.00 kHz

2.2.3.5 THD+N Inherent Distortion

Set UPL:

Generator	
INSTRUMENT	ANALOG
Channel(s)	1
Output	*)
FUNCTION	SINE
Low Dist	ON
FREQUENCY	*)
VOLTAGE	*)

*) set according to test report

Measuring instrument:

Analyzer for THD+N: UPD

Setting of the UPD analyzer for:

22 kHz test bandwidth	
Analyzer	
INSTRUMENT	ANLG 22kHz
Channel(s)	1
Ch1 Input	*)
Ch1 Range	AUTO
FUNCTION	THD+N/SINAD
Dyn Mode	PRECISION
Unit	dB
FrqLim Low	20.00 Hz
FrqLim Upp	21.90 kHz

100 kHz test bandwidth	
Analyzer	
INSTRUMENT	ANLG 110kHz
Channel(s)	1
Ch1 Input	sf *)
Ch1 Range	AUTO
FUNCTION	THD+N/SINAD
Dyn Mode	PRECISION
Unit	dB
FrqLim low	150.00 Hz
FrqLim upp	100.00 kHz

*) set according to UPL generator Output,
Input BAL with impedance 20 kΩ.

Test setup: Connect UPD analyzer to output of UPL generator
Output BAL: Use balanced cable (XLR).
Output UNBAL: Use adapter XLR female to BNC female and an unbalanced cable (BNC).

Measurement: Further UPL setting and measurement according to test report.

2.2.4 Performance Test UPL-B2, Digital Audio I/O

Before starting the test, set the UPL to a defined initial status.
To this end, call the default setting in the FILE Panel under the menu item
LOAD INSTRUMENT STATE → Mode → DEF SETUP.
For testing the rated specifications of the Option UPL-B2 it is recommended to use the following test procedure:

2.2.4.1 Digital Generator

Set UPL:

Generator	
INSTRUMENT	DIGITAL
Src Mode	AUDIO DATA
Channel(s)	2 = 1
Unbal Out	AUDIO OUT
Cable Sim	OFF
Sync To	GEN CLK
Sample Frq	VALUE: 48000 Hz
Sync Out	GEN CLK
Type	WORD CLK
Ref Out	REF GEN
Data	ALL ZERO
Audio Bits	20
Unbal Vpp	see measurement
Bal Vpp	see measurement
FUNCTION	SINE
FREQUENCY	991.00 Hz
VOLTAGE	0.5000 FS

Analyzer	
INSTRUMENT	DIGITAL
Meas Mode	AUDIO DATA
Channel(s)	BOTH
Input	see measurement
Sync To	AUDIO IN
Sample Frq	48 kHz
Audio Bits	20
START COND	AUTO
Delay	0.0000 s
FUNCTION	THD+N/SINAD
Meas Mode	THD+N
Rejection	NARROW
Unit	dB
Filter	OFF
Fnct Settl	OFF

- Level accuracy of the UNBAL output

  Measuring instrument:

  oscilloscope

  Measurement: Connect the oscilloscope to the UNBAL output of the UPL via a 75-Ω cable and a 75-Ω termination.
  Level setting and measurement according to test report.

  Adjustment: The level of the UNBAL or BAL output can be adjusted using potentiometer R13 (TX AMPL) on the front panel module of the Option UPL-B2, if necessary.

- Level accuracy of the BAL output

  Measuring instrument:

  Oscilloscope with probe 10:1

  Measurement: In order to facilitate matching of the balanced output to the unbalanced input of the oscilloscope, the open-circuit voltage of the BAL output is measured using a high-impedance probe and without termination.
  Connect the oscilloscope with probe (BNC) and XLR/BNC adapter to the BAL output of the UPL.
  Level setting and measurement according to the test report.

  Note: If the option UPL-B22 is available, the input pulse amplitude of the digital signals can be directly measured. The easiest way of checking the level accuracy is to proceed according to the respective chapter of the option UPL-B22.

- Frequency accuracy of the internal clock rate

  Measuring instrument:

  Frequency counter

  Measurement: Connect frequency counter to SYNC output of UPL.
  Setting of clock rate and measurement according to the test report.

- External generator synchronization

  Additional UPL settings:

  Generator: SYNC To → SYNC IN
  Sync Mode → WORD CLK
  Sync Out → SYNC PLL
  Type → WORD CLK

  Measuring instrument:

  Frequency counter
  TTL clock generator 27...55 kHz

  Measurement: Connect frequency counter to SYNC output of UPL
  Connect TTL clock generator 27...55 kHz to SYNC IN
  Compare the set clock rate on the external generator with the display on the frequency counter.

- Digital signal generation

  Note: The digital signal generation is accomplished by respective programming of the signal processor. Proper functioning should be checked by means of a loop measurement using the digital analyzer. (See also section function testing, chapter 5.1.1, page 5.1)

2.2.4.2 Digital Analyzer

Set UPL:

Generator	
INSTRUMENT	DIGITAL
Src Mode	AUDIO DATA
Channel(s)	2 = 1
Unbal Out	AUDIO OUT
Cable Sim	OFF
Sync To	GEN CLK
Sample Frq	VALUE:
	48000 Hz
Sync Out	GEN CLK
Type	WORD CLK
Ref Out	REF GEN
Data	ALL ZERO
Audio Bits	24
Unbal Vpp	0.1000 V
Bal Vpp	0.4000 V
FUNCTION	SINE
FREQUENCY	991.00 Hz
VOLTAGE	1.0000 FS

Analyzer	
INSTRUMENT	DIGITAL
Meas Mode	AUDIO DATA
Channel(s)	BOTH
Input	see measurement
Sync To	AUDIO IN
Sample Frq	48 kHz
Audio Bits	24
START COND	AUTO
Delay	0.0000 s
FUNCTION	THD+N/SINAD
Meas Mode	THD+N
Rejection	NARROW
Unit	dB
Filter	OFF
Fnct Settl	OFF

- Testing the digital inputs

  Test: Connect the individual digital inputs of the UPL (BAL, UNBAL, OPTICAL) one after the other to the corresponding digital output of the UPL.
  Select the input to be tested on the analyzer (Input).
  Compare the measured values for Input PEAK and Frequency displayed on the analyzer with the settings on the generator.
  Setting and measurement according to the test report.

- Test functions

  Note: The complete test functions of the digital analyzer are determined by programming the analyzer DSP. Function testing of the hardware can therefore be restricted to a striking test function. The loop measurement simultaneously checks the digital generator and proper functioning of the DSP algorithms.

  Test setup: Connect the digital analyzer input to the digital generator output (INTERN, BAL, UNBAL or OPTICAL).

  Measurement: Perform THD+N measurement (function THD+N/SINAD) and compare measured values with test report.

2.2.5 Performance Test UPL-B21 (Protocol Analysis)

Before starting the test, set the UPL to a defined initial status. To this end, call the default setting in the FILE Panel under the menu item LOAD INSTRUMENT STATE → Mode → DEF SETUP.

For checking the rated specifications of the option UPL-B21 it is recommended to use the following test procedure:

Note: The digital protocol generation is accomplished by respective programming of the interface devices. To check proper functioning of the protocol generator and the correct display of the protocol analyzer, a loop measurement of generator and analyzer is used.

2.2.5.1 Professional Format

Set UPL:

Generator	
INSTRUMENT	DIGITAL
Src Mode	AUDIO DATA
Channel(s)	2 = 1
Unbal Out	AUDIO OUT
Cable Sim	OFF
Sync To	GEN CLK
Sample Frq	VALUE: see measurement
Sync Out	GEN CLK
Type	WORD CLK
Unbal Vpp	1.000 V
PROTOCOL	ENHANCED
Valid Chan	1 & 2
Ch Stat. L	PANEL+AES3
Ch Stat. R	EQUAL L
User Mode	ZERO
Panelname	R&S_AES3.PP

Analyzer	
INSTRUMENT	DIGITAL
Meas Mode	AUDIO DATA
Channel(s)	BOTH
Input	see measurement
Sync To	AUDIO IN
Sample Frq	48 kHz
Audio Bits	20
START COND	AUTO
Delay	0.0000 s
INPUT DISP	PEAK
FREQ/PHASE	SAMPLE FREQ
FUNCTION	PROTOCOL

- Channel status and user data

  Test setup: Connect digital analyzer input to digital generator output (INTERN, BAL, UNBAL or OPTICAL).

  Test: Compare the status and user data displayed on the analyzer protocol window with the settings on the generator.

- Clock rate measurement

  Measuring instrument:

  Frequency counter

Test setup: Connect digital analyzer input to digital generator output (INTERN, BAL, UNBAL or OPTICAL).
For the clock rate measurement connect frequency counter to SYNC OUT.

Measurement: Set the sampling rate on the generator according to the test report and compare the measured values displayed on the analyzer protocol window with the display on the frequency counter.
Maximum frequency offset according to test report.

2.2.5.2 Consumer Format

Set UPL:

Generator	
INSTRUMENT	DIGITAL
Src Mode	AUDIO DATA
Channel(s)	2 = 1
Unbal Out	AUDIO OUT
Cable Sim	OFF
Sync To	GEN CLK
Sample Frq	VALUE: see measurement
Sync Out	GEN CLK
Type	WORD CLK
Unbal Vpp	1.000 V
PROTOCOL	ENHANCED
Valid Chan	1 & 2
Ch Stat. L	PANEL+CRC
Ch Stat. R	EQUAL L
User Mode	ZERO
Panelname	R&S_CONS.PP

Analyzer	
INSTRUMENT	DIGITAL
Meas Mode	AUDIO DATA
Channel(s)	BOTH
Input	see measurement
Sync To	AUDIO IN
Sample Frq	48 kHz
Audio Bits	20
START COND	AUTO
Delay	0.0000 s
INPUT DISP	PEAK
FREQ/PHASE	SAMPLE FREQ
FUNCTION	PROTOCOL

- Channel status and user data

Test setup: Connect digital analyzer input to digital generator output (internal, BAL, UNBAL or OPTICAL).

Test: Compare the status and user data displayed on the analyzer protocol window with the settings on the generator.

2.2.6 Performance Test UPL-B22 (Jitter/Interface test)

Before starting the test, set the UPL to a defined intial status. To this end, call the default setting in the FILE Panel under the menu item LOAD INSTRUMENT STATE → Mode → DEF SETUP.

For testing the rated specifications of the Option UPL-B22 it is recommended to use the following test procedure:

Note: For testing the individual functions of the generator as well as the measurement functions of the analyzer a loop measurement is performed. Thus the number of measuring instruments required for testing is reduced.

2.2.6.1 Common-mode Operation

Set UPL:

Generator	
INSTRUMENT	DIGITAL
Src Mode	COMMON MODE
Unbal Out	AUDIO OUT
Cable Sim	see measurement
Sync To	GEN CLK
Sample Frq	48 kHz
Sync Out	GEN CLK
Type	WORD CLK
Ref Out	REF GEN
Data	ALL ZERO
Unbal Vpp	see measurement
FUNCTION	SINE
FREQUENCY	see measurement
VOLTAGE	see measurement

Analyzer	
INSTRUMENT	DIGITAL
Meas Mode	COMMON MODE
Input	see measurement
START COND	AUTO
Delay	0.0000 s
INPUT DISP	PEAK
FREQ/PHASE	see measurement
FUNCTION	RMS & S/N
Filter	OFF
POST FFT	OFF
SPEAKER	OFF

- Level measurement of the UNBAL input

  Measurement: Set analyzer input to UNBAL.
  Connect UNBAL output of the UPL to the UNBAL input (75-Ω cable) and compare the display of the measured level on the UPL with the set generator level.
  Level setting and measurement according to test report.

- Level measurement of the BAL input

  Measurement: Set analyzer input to BAL.
  Connect BAL output of the UPL to BAL input (XLR cable) and compare the display of the measured level on the UPL with the set generator level.
  Level setting and measurement according to test report.

- Common-mode amplitude

  Measurement: Set analyzer input to BAL.
  Connect the BAL output of the UPL to the BAL input (XLR cable) and compare the display of the measured common-mode amplitude at 1 kHz with the common-mode amplitude set on the generator.
  Setting of common-mode amplitude and measurement according to test report.

- Common-mode frequency response

  Measurement: Set analyzer input to BAL.
  Connect BAL output of UPL to BAL input (XLR cable).
  Setting of the common-mode frequency and amplitude measurement according to test report.
  If installed, the low-distortion generator (UPL-B1) is used.
  In this case, the frequency response can be measured up to 100 kHz.

- Sampling rate

  Measuring instrument:

  Frequency counter

  Measurement: For the clock rate measurement, connect the frequency counter to SYNC OUT.
  Set the sampling rate on the generator according to the test report and compare the measured values displayed on the analyzer protocol window with the display on the frequency counter.
  Maximum frequency offset according to test report.

- Cable simulator

  Measuring instrument:

  Oscilloscope

  Test setup: Connect the oscilloscope to the UNBAL output of the UPL via a 75-Ω cable and a 75-Ω termination.
  Connect the BAL output of the UPL to the BAL input (XLR cable).

Measurement: UNBAL output:
Switch on the cable simulator in the generator menu and check the pulse shape of the digital signal at the output.
If the cable simulator is switched on, the rise time of the digital signal is clearly reduced at the UNBAL output.
The increase is very flat in the 90% range so that a large measurement tolerance is to be taken into account here.
Compare the rise time with the values in the test report.

Measurement: BAL output:
Set UNBAL Out to AUDIO IN in the generator menu.
Thus the UPL input signal (BAL) is output again at the UNBAL output so that it can be examined on the oscilloscope.
If the cable simulator is switched on, the rise time of the digital signal is clearly reduced at the BAL output, which is now applied to the oscilloscope via the UNBAL output.
The increase is very flat in the 90% range so that a large measurement tolerance is to be taken into account here.
Compare the rise time with the values in the test report.

2.2.6.2 Input/Ref phase shift

Set UPL:

Generator	
INSTRUMENT	DIGITAL
Src Mode	PHASE
PhaseToRef	see measurement
Unbal Out	AUDIO OUT
Cable Sim	OFF
Sync To	GEN CLK
Sample Frq	48 kHz
Sync Out	GEN CLK
Type	WORD CLK
Ref Out	REF GEN
Data	ALL ZERO
Unbal Vpp	1.0000 V
FUNCTION	SINE
FREQUENCY	1000.0 Hz
VOLTAGE	0.5000 FS

Analyzer	
INSTRUMENT	DIGITAL
Meas Mode	JITTER/PHAS
Input	BAL (XLR)
Jitter Ref	GEN CLK
START COND	AUTO
Delay	0.0000 s
INPUT/PHAS	PHAS TO REF
FREQ/PHASE	SAMPLE FREQ
FUNCTION	RMS & S/N
Filter	OFF
POST FFT	OFF
SPEAKER	OFF

- Generator phase shift and measurement

Adjustment: Perform the PhaseToREF adjustment in the OPTIONS Panel under CALIBRATION DIG.
The phase generation and the phase measurement are thus adjusted.

Test setup: Connect the digital analyzer input to the digital generator output (internal, BAL, UNBAL or OPTICAL).
Connect REF IN to REF OUT at the rear of the UPL.

Measurement: Vary the Frame Phase on the generator and compare with the measured display on the UPL analyzer.
Phase setting and measurement according to test report.

Note: When using long cable connections of the respective inputs/outputs, an additional measurement uncertainty is involved. Therefore, XLR cables of the same length should be used between digital input/output and REF input/output with a maximum length of approx. 5m.
Measured values with ±50% Frame Phase are not unambiguous so that a positive or negative value can be displayed here.

2.2.6.3 Jitter Generation and Measurement

Jitter measurement with generator and analyzer

Note: The individual functions of the generator and the measurement functions of the analyzer are checked by means of a loop measurement. Thus the number of measuring instruments required is reduced.
A modulation analyzer for phase modulation can be used for checking the measurement results of the jitter analyzer. It must be capable of measuring a phase deviation (peak value) of at least $\pm 1\pi$ (± 3.14 rad) at 6.144 MHz.

Set UPL:

Generator	
INSTRUMENT	DIGITAL
Src Mode	JITTER
Unbal Out	AUDIO OUT
Cable Sim	OFF
Sync To	GEN CLK
Sample Frq	see measurement
Sync Out	see measurement
Type	BIPHASE CLK
Ref Out	see measurement
Audio Bits	20
Unbal Vpp	1.0000 V
FUNCTION	SINE
Low Dist	see measurement
Jitt Freq	see measurement
JittPkAmpl	see measurement

Analyzer	
INSTRUMENT	DIGITAL
Meas Mode	JITTER/PHAS
Input	see measurement
Jitter Ref	see measurement
INPUT/PHASE	PEAK
FREQ/PHASE	FREQ
START COND	AUTO
Delay	0.0000 s
FUNCTION	RMS & S/N
Meas Time	AUTO
Filter	OFF
POST FFT	OFF
SPEAKER	OFF

- Jitter amplitude

  Measuring instruments:

  Modulation analyzer for phase modulation (for checking the measured values).

  Test setup: Connect the digital analyzer input to the digital generator output (INTERN, BAL, UNBAL or OPTICAL).
  Connect the modulation analyzer to SYNC OUT.

  Measurement: Vary the jitter frequency on the generator and compare with the Jitter Input Peak display on the analyzer.
  Measurement at the standard sampling rates (32 kHz, 44.1 kHz and 48kHz) with respective sync PLL of the analyzer as jitter reference.
  Measurement at variable sampling rates 27 kHz...55 kHz with internal generator (REF GEN as jitter reference).
  Switch off weighting filter during jitter measurement.
  Generator setting and measurement according to test report.

  Adjustment: The jitter amplitude can be adjusted using potentiometer R246 (TX Jitter) on the AES main board of the option UPL-B2, if necessary.

Note: A jitter amplitude of 0.5 UI (peak) corresponds to a modulation deviation of 3.14 rad (peak) of the bi-phase clock applied to SYNC OUT and which can be used for measurement of the modulation analyzer.
To this end, set the SYNC output to AUDIO IN and Type to BIPHASE CLK in the Generator menu.

- Jitter frequency response

Measurement: Vary the jitter frequency on the generator and compare with the Jitter Input Peak display on the analyzer.
When using the built-in low-distortion generator, the frequency response can be measured up to 100 kHz.
Measurement at the standard sampling rates (32 kHz, 44.1 kHz and 48 kHz) with the respective sync PLL of the analyzer.
Measurement at variable sampling rates 27 kHz...55 kHz with internal generator (REF GEN as jitter reference)
Generator setting and measurement according to the test report.

Note: When using the VARI PLL as jitter reference of the analyzer, the additional jitter component must be taken into account in the measurement due to the inherent jitter and the larger PLL bandwidth.
Usage of this PLL is to be recommended only if the test item is not to be operated with the generator of the UPL and with variable sampling rate.

- Reclock function

Note: The input signal featuring jitters is sampled with a low-jitter clock from the reference PLL and output again at the REF OUT. With the standard sampling rates (32 kHz, 44.1 kHz and 48 kHz), the respective reference PLL should be used for the jitter measurement.
The reclock function can be used for jitter amplitudes of up to 0.15UI (peak).

Test setup: Connect the digital analyzer input to the digital generator output (INTERN, BAL, UNBAL or OPTICAL).
Connect oscilloscope to XLR/BNC adapter and BNC probe to REF OUT.
Apply oscilloscope trigger to SYNC OUT.

Additional UPL settings:

Generator: Sync Out: SYNC PLL
Type: BIPHASE CLK
REF Out: AUDIO IN RCLK

Measurement: Set sampling rate, jitter amplitude and jitter frequency on the generator according to the test report.
Examine the digital signal at the REF output on the oscilloscope.
The signal shown on the oscilloscope must not contain any jitter. For checking purposes, set the REF output to AUDIO IN in the generator menu in order to view the input signal featuring jitters on the oscilloscope.

Adjustment: The correct phase position for sampling with the low-jitter clock can be adjusted using potentiometer R249 (RECLOCK PHASE) on the AES main board of the Option UPL-B2.

2.2.7 Performance Test UPL-B5, Audio Monitor

Before starting the test, set the UPL to a defined initial status.
To this end, call the default setting in the FILE Panel under the menu item
`LOAD INSTRUMENT STATE → Mode → DEF SETUP`.

Set UPL:

Generator	
VOLTAGE	1.0000 V

Analyzer	
Channel(s)	2 ≡ 1
Input	GEN CROSSED
Range	FIX:
	1.0 V RMS
SPEAKER	INPUT CH1&2
Phone Out	see test

2.2.7.1 Function Test

For checking the specifications (analog) of the option UPL-B5, it is recommended to proceed according to the following test sequence:

- Function of the phone jack

  Phone Out =SPEAKER:

  When connecting external headphones, the internal loudspeaker must not be heard any longer.
  The [LOCAL] key acts on the internal loudspeaker and the connected headphones in the same way.

  Phone Out PERMANENT:

  The internal loudspeaker remains switched on irrespective of the connection of the headphones socket.
  The [LOCAL] key causes the internal loudspeaker to be switched off, the headphones output ,however, permanently remains active.

  When carrying out this function test, observe the sound and the volume of the internal loudspeaker. No distortions should be noticed and, when varying the frequency between 0.4, 1 and 10 kHz, there should be no discernible difference in the volume.

- Switchover of signal source

  Set the generator output to:

  Channel(s) 1 — A tone may be heard only from the right earpiece of the headphones (not from the left one because of the setting `GEN CROSSED`)

  Channel(s) 2 — A tone may be heard only from the left earpiece of the headphones.

  Channel(s) 2≡1 — A tone of the same volume must be heard from both earpieces.

The same test is to be carried out when setting the digital instrument (digital generator and digital analyzer).

Set UPL:

Generator	
INSTRUMENT	DIGITAL
VOLTAGE	1.0000 FS
Sample Frq	VALUE: see test lock-in range of the PLL

Analyzer	
INSTRUMENT	DIGITAL
Channel(s)	BOTH
Input	INTERN
SPEAKER	DIG CH1&2

- Switchover of signal source

  Set the generator output to:

  Channel(s) 1 A tone may be heard only from the left earpiece of the headphones

  Channel(s) 2 A tone may be heard only from the right earpiece of the headphones.

  Channel(s) 2≡1 A tone of the same volume must be heard from both earpieces.

- Lock-in range of the PLL

  For this test, the previously selected setting (digital domain) is maintained and the audio clock is changed in the generator panel. Set the following clock frequencies (Sample Frq): 27, 41 and 55 kHz. The tone generated by the audio monitor must always sound the same irrespective of the clock rate.

  Since the analyzer is not changed in terms of the clock rate, the signal frequency measured in this test varies inversely with respect to the clock rate (referred to 48 kHz).

2.2.7.2 Checking the Specifications

For carrying out the following tests of the UPL-B5, it is recommended to use the "analog" setting (as described at the beginning of this section).
For checking the specifications, it is advisable to use an appropriate audio analyzer. For sequential measurement of the two channels, it is possible to use the other UPL channel by connecting the headphones output to the analyzer inputs (for this purpose, the adapter 6.3mm jack connector to BNC/XLR is used, see section 2.1, page 2.3). An external analyzer or distortion meter is to be used only for testing the inherent distortions in the digital domain.

- Testing the output voltage
- Frequency response of the headphones output
- Inherent distortions THD+N at the headphones output (analog domain)
- Inherent distortions THD+N at the headphones output (digital domain)

2.3 Test Report

2.3.1 Performance Test Report of Analog Generator

Audio Analyzer UPL **Rohde & Schwarz**

UPL / Analog Generator

Order No. 1078.2008 **Date:** . . . . . .

Serial No.: . . . . . **Name:** . . . . . .

measurement		min	act.	max	unit
Sine Level Accuracy at 1 kHz					
Channel(s)	1				
Output	UNBAL				
Voltage	8.0000 V	7.9200		8.0800	V
	4.0000 V	3.9600		4.0400	V
	2.0000 V	1.9800		2.0200	V
	1.0000 V	0.9900		1.0100	V
	0.5000 V	0.4950		0.5050	V
	0.2500 V	0.2475		0.2525	V
	15.000 mV	14.850		15.150	mV
Channel(s)	1				
Output	BAL				
Impedance	10 Ω				
Voltage	16.000 V	15.840		16.160	V
	2.0000 V	1.9800		2.0200	V
	0.5000 V	0.4950		0.5050	V
Channel(s)	2				
Output	UNBAL				
Voltage	2.0000 V	1.9800		2.0200	V
Channel(s)	2				
Output	BAL				
Impedance	10 Ω				
Voltage	4.0000 V	3.9600		4.0400	V
Sine Frequency Response UNBAL					
Channel(s)	1				
Output	UNBAL				
Voltage	2.000 V				
Frequency	10 Hz	−0.1		0.1	dB
	20 Hz	−0.05		0.05	dB
	50 Hz	−0.05		0.05	dB
	100 Hz	−0.05		0.05	dB
	200 Hz	−0.05		0.05	dB

- continued -