

Volt, Phase, & Flutter Meters

type 4416, QR 2009, QR 2010 and QR 2011

Response Test Unit, Test Records

FEATURES:

- Automatic synchronization with B & K equipment
- Possibility of printed documentation
- Fast operation time
- Compliance with IEC R98, DIN 45547, BS 1928: 1961 and RIAA
- Built-in channel selector
- Built-in equalizing filters
- Built-in rumble filters

USES:

- Production control of, and laboratory investigations on, gramophone pick-ups, record players, tape recorders, dictation machines, motion picture sound systems and complete audio reproduction systems
- Cross-talk measurements on stereo systems
- Fast frequency response measurements on audio equipment
- Phase check of complete Hi-Fi systems by simple listening method
- Response test of complete Hi-Fi systems installed in the actual listening room
- Recording of test tapes



The Response Test Unit Type 4416 forms the link between the reference programmes recorded on the Test Records QR 2009, QR 2010 and QR 2011 or on tape recorders etc., and the extensive range of automatic audio system test instruments produced by Brüel & Kjær.

The main function of the instrument is to de-emphasize the output

signal from pick-up cartridges and to start a Level Recorder Type 2306, 2307, 2309 or 2317 so that synchronization is obtained between the frequency sweep on the test record and the frequency calibrated paper on the Level Recorder. In cases where the ability to record is built into the device under test, for instance, tape recorders, dictation machines etc., reference recordings can be made by means of

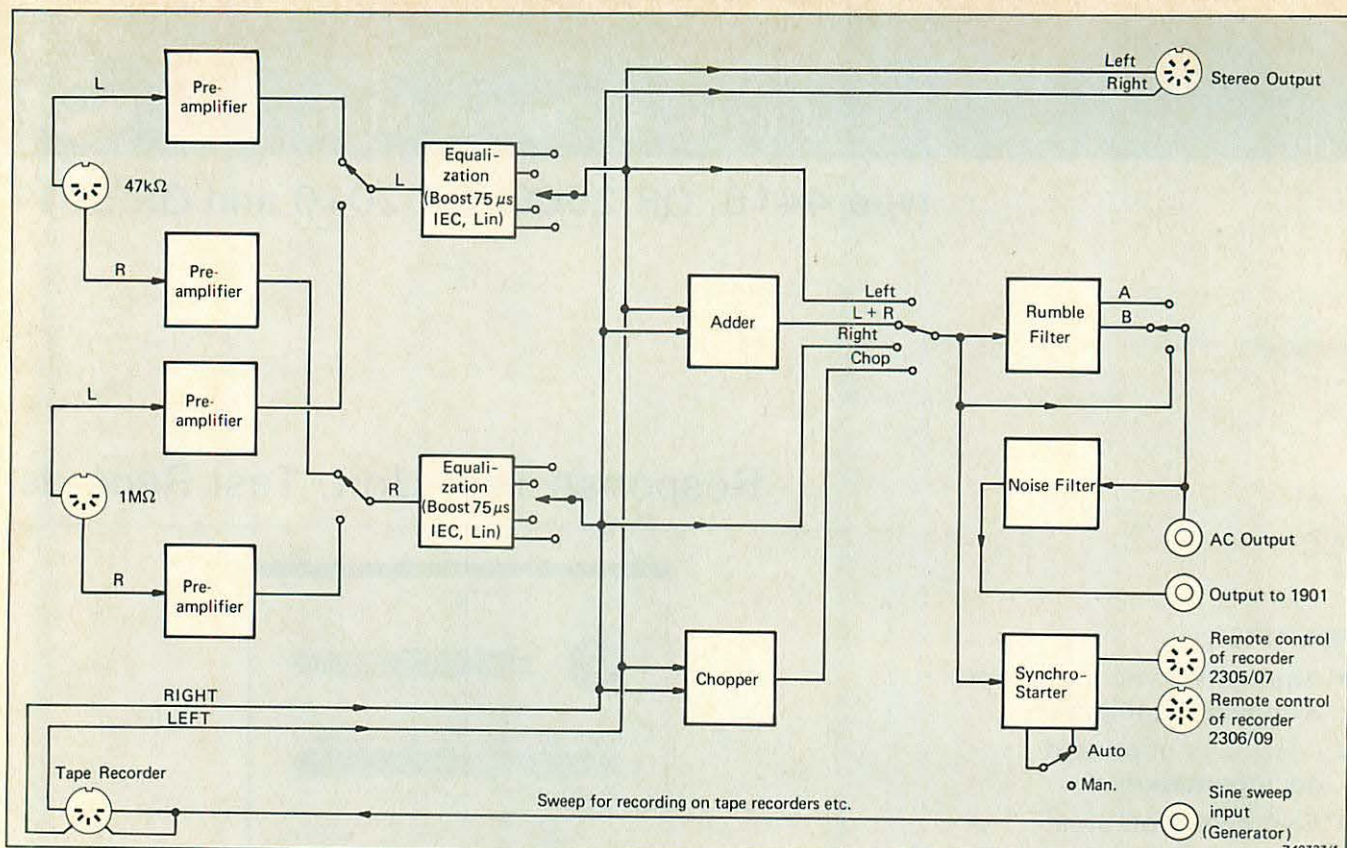


Fig.1. Functional block diagram of the Response Test Unit Type 4416

a Sine Generator Type 1023, automatically swept by the Level Recorder.

The Test Unit has a built-in electronic switch, which allows separation and balance measurements to be made on stereo systems, as well as both standardized rumble weighting filters, A and B (DIN 45539) for measurement of turntable rumble.

Response Test Unit Type 4416

The instrument has three inputs: one designed for measurements on dynamic pick-ups, one for measurements on piezoelectric pick-ups and one for the testing of tape recorders. From the two inputs for pick-up measurements, the stereo signals are fed through a pair of pre-amplifiers giving the signals suitable amplitude for further processing. After amplification, the signals are fed to the equalizing networks designed to apply the required de-emphasis to the signal in all normal situations, they should be used as follows:

- 1) Where a preamplifier with built-in equalization is built into the de-

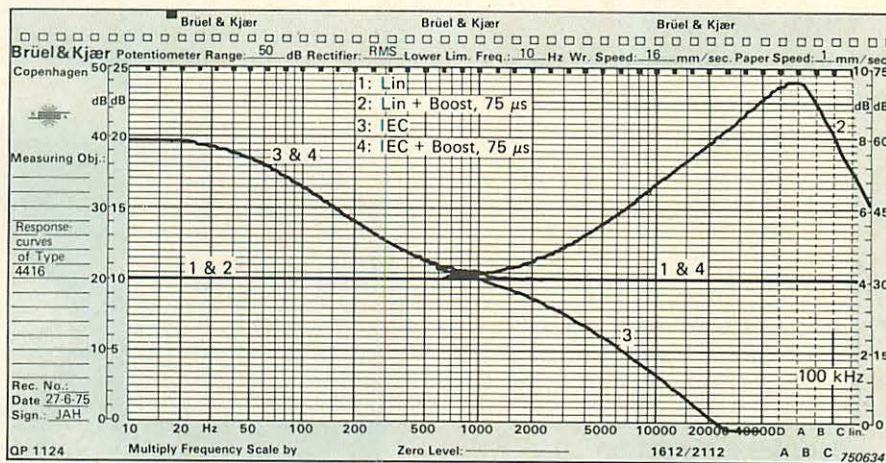


Fig.2. The four different de-emphasis functions built into Type 4416

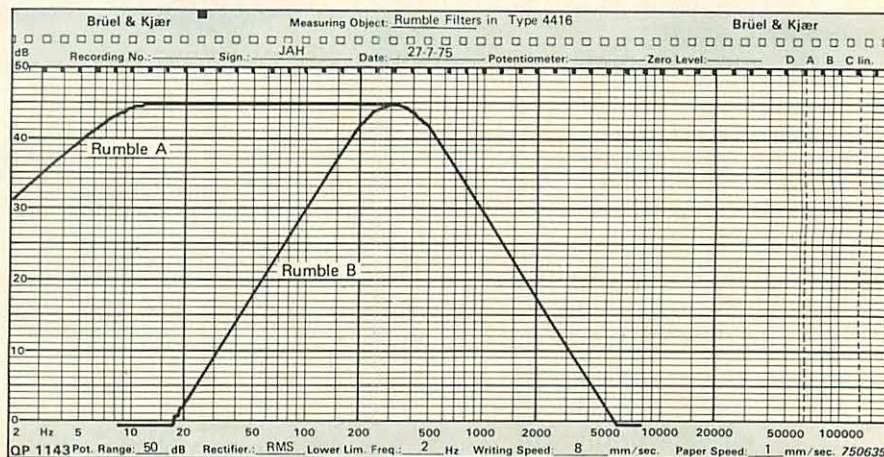


Fig.3. Standardized rumble curves

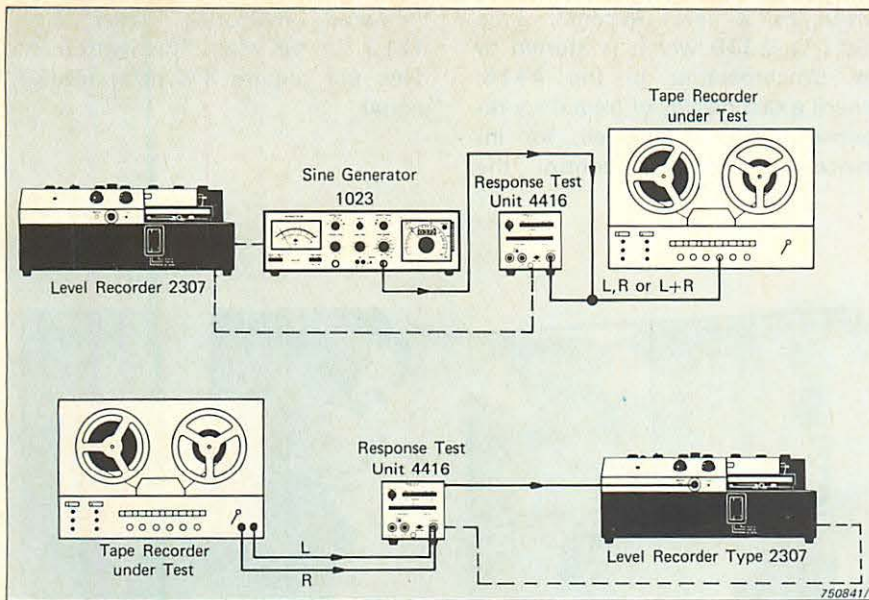


Fig.4. Recording and playback of test tape utilizing the Response Test Unit

vice under test, use is made of the LIN position giving no correction to the signal.

- 2) Where measurements are made on unequalized signals using test records cut to the IEC standard, the IEC position, introducing the standard equalization for record players must be used.
- 3) Where the B & K test records are used, the "Boost, 75 μ s" equalization must be applied, regardless of the setting of the other selectors, because of the special pre-emphasis used on these records. (The reason for and the nature of the B & K pre-emphasis are explained in the section on test records.)

The third input, for tape recorder testing, bypasses these equalization networks.

For monitoring purposes, an output is available after the equalizing circuits.

After the equalization networks, the signals are fed to an adder and a chopper making available, via a selector, a total of four different signals. The chopper operates at a frequency of approx. 1 Hz and is suitable for very detailed analysis of the stereo balance as a function of frequency, and allows graphic records to be made automatically on the Level Recorder Type 2307, 2309, 2317 or earlier Type 2306.

The three remaining positions of the selector, enabling measurement on the Left and Right channels separately and on the sum signal, should need no further explanation.

After passing the adder and chopper, the signal may be applied directly to the output or it may be weighted in one of the standardized rumble filters. The direct route is used for frequency response, crosstalk, balance and other measurements on the pick-up cartridge while the weighted positions are used for measurements of turntable quality.

For automatic swept distortion measurements, an output to the Tracking Frequency Multiplier Type 1901 is available via a noise filter.

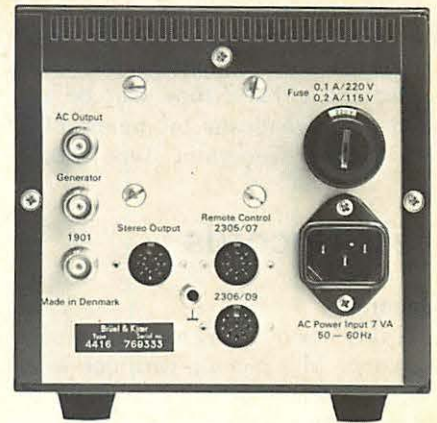


Fig.5. Rear view of Type 4416

Type 1901 is able to control the tuning of the B & K Heterodyne Analyzer Type 2010 or Heterodyne Slave Filter Type 2020 in such a way that their filters automatically follow almost any desired harmonic component in the measured signal. The noise filter is necessary in order to avoid disturbance of the tracking due to clicks and surface noise. For intermodulation measurements, a Distortion Measurement Control Unit Type 1902 can be added to a set-up with the Analyzer Type 2010.

The synchro-starter circuit is used to obtain synchronization between the recorded signals and the frequency calibrated paper used with the Level Recorders. All relevant bands on the B & K Test Records are preceded by a short, sine signal of 1000 Hz. The synchro-starter circuit detects the trailing edge of this tone burst and starts the Level Recorder when the tone ceases.

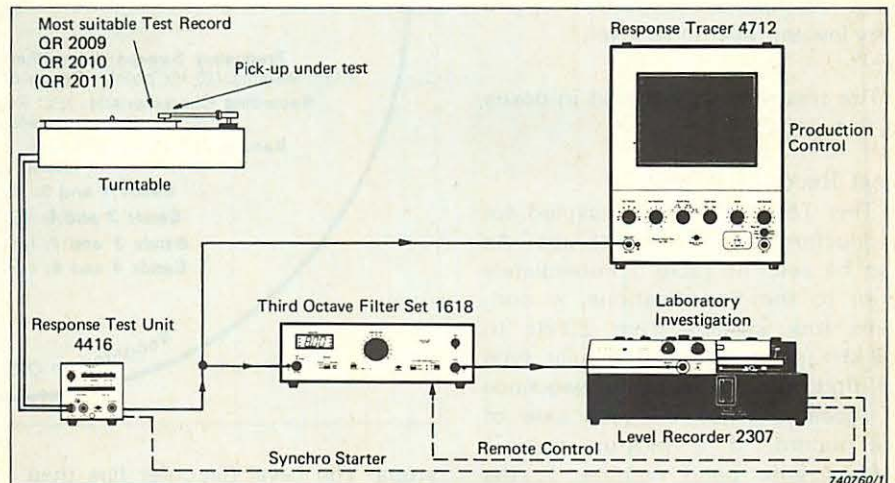


Fig.6. Production control or laboratory investigation of a pick-up cartridge. The Filter Type 1618 is used to increase the signal to noise ratio

When measurements are made on tape recorders, dictation machines etc., a frequency sweep preceded by a 1 kHz tone can be recorded automatically by means of a B & K Sine Generator Type 1023

driven by a Level Recorder Type 2307 or 2309 which is started by the synchrostarter in the 4416. Where a fast display of frequency response curves is desired, for instance in production control, the

Frequency Response Tracer Type 4712 can be used. This instrument does not require a synchronization signal.

Test Records

General

A very obvious way to test the performance of a pick-up cartridge is to replay a record where a number of different signals with well defined characteristics have been accurately recorded. By examining the electrical output, it can be seen how the pick-up performs under exactly the same conditions as are met when it replays ordinary records.

It is well known that ordinary speech and music programmes contain only limited power at higher frequencies. Therefore, when making disc recordings, the upper frequency region is given the greatest gain and the lower the least. However, if a test programme were recorded through the usual pre-emphasis network, the reference level would be too low or recording of the high frequency part would be impossible. On QR 2009 and QR 2010 it was decided to omit the treble boost and use constant level from 1000 Hz. In spite of this, the stylus tip acceleration approaches 1000 g at the highest frequencies on QR 2010.

The materials for the three test records available from Brüel & Kjær are selected and treated with great care in order to obtain the best possible mechanical properties and a very low surface noise level.

The test records are sold in boxes of five.

Test Record QR 2009

This Test Record is designed for production control of pick-ups. As can be seen in Table 1 immediately prior to the Specifications, it contains four sweeps from 20 Hz to 20 kHz each with a particular type of modulation. This signal sequence is repeated twice on each side of the record. If a pick-up test is started with band number 1, the pick-up automatically proceeds through bands 2, 3 and 4 and then

stops. The Level Recorder has then also stopped and is ready to receive the new synchronization burst when

it arrives from the pick-up. If it is desired to record the response to more than one modulation type on



the same piece of recording paper, it is done by rewinding the paper strip after the recording has stopped and placing the pick-up at the beginning of the desired band. The sweep duration on all bands is 50 s and the recording characteristics plus all other data are in accordance with IEC R 98 and R 98-1, except for constant velocity above 1000 Hz.

up units and for detailed investigations on production samples. Modern pick-ups are of extremely lightweight construction with very large compliance and wide frequency range — but also with a wide spread in specifications. Therefore, testing of production samples is an excellent means of maintaining a high and stable level of quality.

Test Record QR 2010

This Test Record is designed for laboratory measurements on pick-

The two sides of QR 2010 are identical and the programme can be seen in Table 1, prior to the Specifi-

cations. Bands 8, 11 and 15 are designed to perform various measurements on record players while the rest are for pick-up measurements.

Bands 3 to 7 incl. are designed to determine the maximum velocity which a pick-up stylus can be given via a recorded signal. If the stylus cannot follow the groove, a high degree of distortion will occur, in severe cases the stylus will jump out of the groove.

Band 9 is for polarity check of the leads to the pick-up after first having checked that the L signal occurs when the L-button is pressed and vice versa. If the polarity is correct, the signal on the L + R output of Type 4416 will disappear when the pick-up passes the L—R signal. If they are reversed the opposite will occur.

Bands 10 and 12 are both intended for crosstalk measurement when only a voltmeter is available. First, a calibration signal is applied to the channel which is connected to the voltmeter. Then the measuring signal occurs in the other channel. The two signals have a difference in level which, in most cases, makes it unnecessary to change the voltmeter attenuator position.

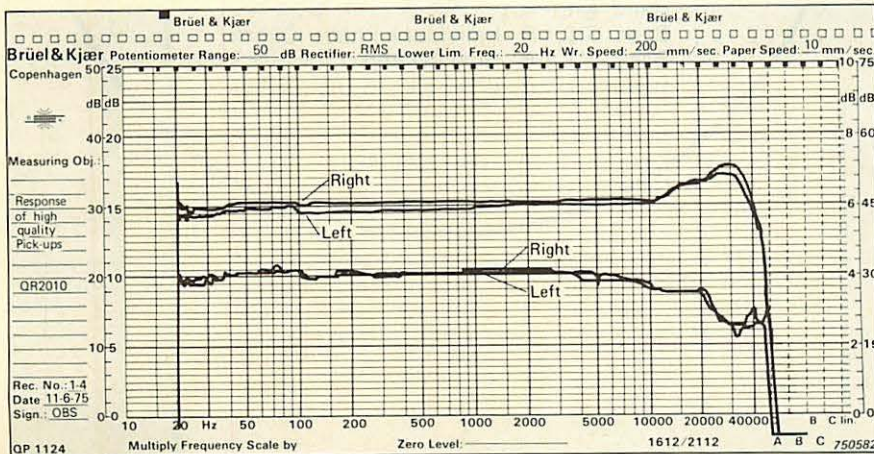


Fig. 7. Response of two modern, high quality pick-ups to the 20 Hz to 45 kHz sweep on QR 2010. The vertical displacement is not due to different sensitivities but was arranged for clarity



Test Record QR 2011

This Test Record is designed to test complete audio reproduction systems when they are installed in the actual listening room. Too often, it is found that the ultimate quality is more influenced by the acoustic properties of the room than by the amount spent on the electronics. Therefore, this record was designed to provide users and dealers of Hi-Fi equipment with an inexpensive and easy-to-use tool, which gives accurate and reliable results for a quality evaluation. The signal consists of pink-weighted, random noise fed through a 1/3 octave filter which is stepped through the entire audio range. The measurement takes place from the user's favourite listening position, where a Sound Level Meter is placed. (The Types 2230, 2231, 2233, 2234 and 2235 are recommended). On the frequency calibrated paper QP 2011, supplied with the records, the total system response is plotted from the Sound Level Meter readings. Since the measurements take place in the actual listening room, its acoustic behaviour is automatically taken into account.

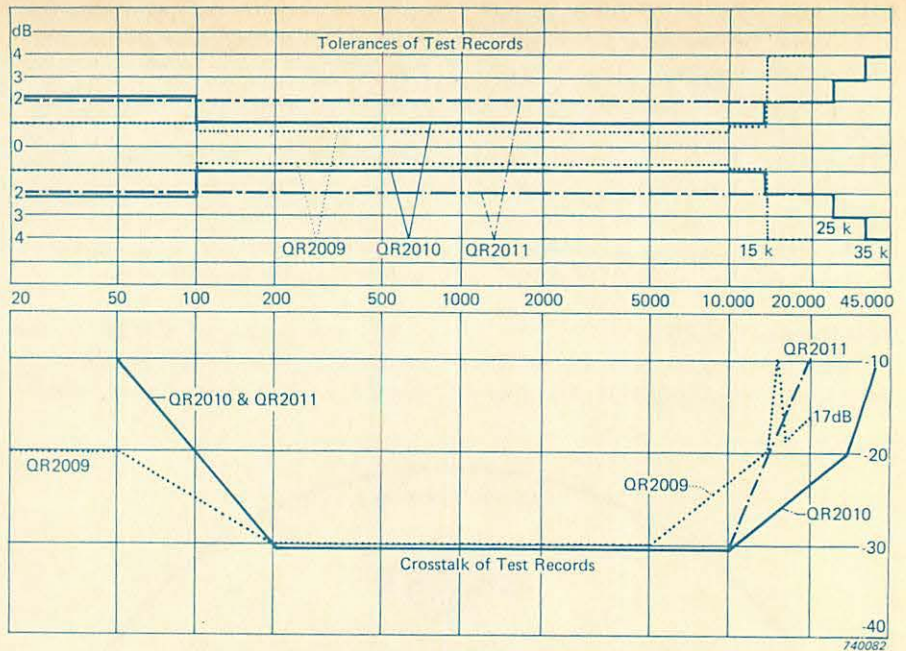


Fig.8. Tolerances and crosstalk of the test records



Brüel & Kjær
Nærum, Denmark

Pink Noise Test Record B

Type QR 2011 (St) 33

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- Band 1 L+R, Calibration
- Band 2 L+R, Measuring Signals
- Band 3 L+R, Measuring Signals
- Band 4 L+R,) Total Phase Check
- Band 4 L-R, (
- Band 5 L+R, Individual Phase Check
- Band 6 L+R, Sine Sweep
- Band 7 L+R, Wide Range Distribution

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Table 1. B & K Test Record programmes QR 2009, QR 2010 and QR 2011 (see opposite page)

	Band No.	Type of Modulation	Level*)	Accuracy	Frequency	Duration	Sync Burst	Remarks	Applications
QR 2009	1 & 5	Left	-10 dB	± 1 dB	20 Hz to 20 kHz log. sweep	16,7 s/dec., total 50 s	Yes	For sweep accuracy and crosstalk see Fig. 8.	Frequency response, cross- talk and balance measure- ments
	2 & 6	Right							
	3 & 7	L + R							
	4 & 8	L - R							
QR 2010	1	Left	-10 dB	± 1 dB	20 Hz to 45 kHz log. sweep	5 s/dec., total 16,7 s	Yes	For sweep accuracy and crosstalk see Fig. 8.	Frequency response and cross- talk measurements
	2	Right							
	3	L + R	+ 8 dB	± 0,5 dB	1 kHz	15 s each	No	Distortion < 4% Distortion < 3% Distortion < 1% Distortion < 1% Distortion < 1%	Determination of maximum tracking ability
	4	L + R	+ 6 dB						
	5	L + R	+ 4 dB						
	6	L + R	+ 2 dB						
	7	L + R	0 dB						
	8	L + R	-12 dB	± 1 dB	3150 Hz	60 s	No	Max. Wow < ±0,06% (peak, weighted)	Wow measurements on turn- tables
	9	Left	0 dB	± 0,5 dB	1 kHz	3 s	No		Quick polarity check
		Right				3 s			
		L + R				1 s			
		L - R				1 s			
		L + R				1 s			
	10	Left	-20 dB	± 2 dB	30 kHz	5 s each	No	Crosstalk > 20 dB	Crosstalk measurements at 30 kHz in 4-channel transdu- cers
		Right	-10 dB						
	Right	-20 dB							
	Left	-10 dB							
11	L + R	-11,3 dB	± 1 dB	315 Hz	15 s	No	Rumble according to IEC-method A-Weighting < 50 dB B-Weighting < 65 dB	Rumble measurements on turntables	
	Empty				60 s	No			
12	Left	-20 dB	± 1 dB	1 kHz	3 s	No	Crosstalk > 20 dB > 30 dB at 1 kHz	Crosstalk measurement re- quiring only an AC-voltmeter	
	Right	0 dB		1 kHz	2 s				
	Right	0 dB		400 Hz to 10 kHz log. sweep	5 s/dec., total 7 s				
	Right	-20 dB		1 kHz	3 s				
	Left	0 dB		1 kHz	2 s				
	Left	0 dB		400 Hz to 10 kHz log. sweep	5 s/dec., total 7 s				
13	Left	-10 dB	± 1 dB	20 Hz to 20 kHz log. sweep	5 s/dec., total 15 s	Yes	For sweep accuracy and crosstalk see Fig. 8.	Measurement of response and crosstalk at small me- chanical wavelengths	
14	Right	-10 dB							
15	L + R	-20 dB	± 2 dB	5 Hz to 20 Hz log. sweep	50 s/dec., total 30 s	Yes	Constant velocity	Investigations of arm reso- nances	
QR 2011A	1	Left	-22 dB	± 1 dB	1 kHz, 1/3 oct. Noise	60 s	No	At the beginning of each band a voice states centre frequency	Calibration
	2	Left			20 Hz to 20 kHz, 1/3 oct. Noise	500 s	Yes		Manual response measure- ment in listening room
	3	Right			1 kHz, 1/3 oct. Noise	60 s	No		Calibration
	4	Right			20 Hz to 20 kHz, 1/3 oct. Noise	500 s	Yes		Manual response measure- ment in listening room
QR 2011B	1	L + R	-22 dB	± 1 dB	1 kHz, 1/3 oct. Noise	60 s	No	At the beginning of each band a voice states centre frequency	Calibration
	2	L + R			20 Hz to 20 kHz, 1/3 oct. Noise	500 s	Yes		Manual response measure- ment in listening room
	3	L + R	-22 dB	± 1 dB	20 Hz to 20 kHz, 1/3 oct. Noise	150 s	Yes	No voice comments	Automatic response measure- ment in listening room
	4	L + R	-24 dB	± 1 dB	20 Hz to 20 kHz, Wideband Noise	30 s each	No	Correct phase Reversed phase	Phase check of the entire system
		L - R							
	5	L + R	-22 dB	± 1 dB	20 Hz to 1 kHz, Noise	15 s each	No		Individual phase check
		L + R			1 kHz to 4 kHz, Noise				
	L + R	4 kHz to 20 kHz, Noise							
6	L + R	-10 dB	± 1 dB	20 Hz to 1 kHz, Sine	85 s	Yes		Tracing resonating parts	
7	L + R	-24 dB	± 1 dB	20 Hz to 20 kHz, Wideband Noise	240 s	No		Room distribution of wide range signal	

*) Relative to 10 cm/s RMS, Lateral (L + R) at 1000 Hz

Specifications 4416, QR 2009, QR 2010 and QR 2011

RESPONSE TEST UNIT 4416:

Pick-Up Inputs:

High Level:

Impedance: 1 M Ω // max. 15 pF

Max. Voltage: 1,5 V peak

Low Level:

Impedance: 47 k Ω // max. 15 pF

Max. Voltage: 15 mV peak

Tape Input:

Impedance: 47 k Ω // max. 25 pF

Max. Voltage: 5 V peak

Gain at 1 kHz:

High Level Input: 10 dB

Low Level Input: 50 dB

Tape Input: 0 dB

Accuracy: \pm 0,3 dB

Frequency Range:

5 Hz to 50 kHz \pm 0,3 dB incl. filters

Balance Between Channels:

Better than 0,2 dB

Equivalent Input Noise:

High Level Input: $<$ 0,5 mV

Low Level Input: $<$ 10 μ V

Tape Input: $<$ 1 mV

Equalization:

1. LIN: Linear 5 Hz to 50 kHz

2. LIN + Boost: 75 μ

3. IEC: 75 318/3180 μ s

4. IEC + Boost: 318 3180 μ s

IEC curve in accordance with IEC 98, DIN 45 547, B.S. 1928:1961 and several other standards

Rumble Filters:

A and B weighting in accordance with IEC 98 A and DIN 45 539. See Fig. 3

Equivalent Input Noise with Rumble Measurements:

	Low Level	High Level
A-filter:	$<$ 3 μ V [*]	$<$ 300 μ V
B-filter:	$<$ 1 μ V	$<$ 100 μ V

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Harmonic Distortion:

General Condition $V_o = 1 V_{RMS}$

LIN + Boost and IEC:

$<$ -60 dB, 20 Hz to 20 kHz

$<$ -50 dB, 5 Hz to 50 kHz

All other Curves:

$<$ -70 dB, 20 Hz to 20 kHz

$<$ -60 dB, 5 Hz to 50 kHz

Nonlinear Distortion:

Measured in accordance with IEC 268-3 and DIN 45 403 at $V_o = 1 V$

IM Distortion:

Typically no sidebands will exceed:

-70 dB, 20 Hz to 20 kHz

-60 dB, 5 Hz to 50 kHz

(all curves)

Difference Frequency Distortion:

Typically no sidebands will exceed:

-55 dB, 20 Hz to 20 kHz

(IEC and LIN + Boost)

-70 dB, 20 Hz to 20 kHz

-60 dB, 5 Hz to 20 kHz

(all other curves)

Crosstalk:

Measured in the channel with input shorted

	1 kHz	20 kHz	50 kHz
Pick-up 47 kΩ:	65 dB	45 dB	35 dB
Pick-up 1 MΩ:	65 dB	40 dB	30 dB
Tape:	65 dB	45 dB	35 dB

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Synchrostarter:

Automatic or Manual: Sensitive to signal as follows:

Frequency: 1000 \pm 50 Hz

Duration: $>$ 100 ms

Voltage: $>$ 10 mV (Pick-up)

$>$ 100 mV (Tape Recorder)

Output Voltage:

Max. 5 V peak

Output Impedance:

AC Output: $<$ 150 Ω , R_{LOAD} min 10 k Ω

Stereo Output: 4,7 k Ω

Temperature Range:

+ 5 to 40°C (41 to 104°F)

Max. Humidity:

90% RH (non condensing) at 30°C

Power Supply:

100 to 240 V AC \pm 10%

50 to 60 Hz 7 VA

Complies with safety class I of IEC 348

Dimensions:

Width: 139,5 mm (5,5 in)

Height: 132,6 mm (5,2 in)

Depth: 200 mm (7,9 in)

(B & K module cabinet KK 0024, 4/12 of 19" rack module)

Accessories Included:

1 \times Power Cable	AN 0010
1 \times Remote Control Cable	AO 0035
1 \times B & K to BNC Cable	AO 0127
1 \times BNC Plug	JP 0035
4 \times 5-pin DIN Plug	JP 0506
2 \times 0,2 A Fuses	VF 0012
1 \times 0,1 A Fuse	VF 0026

TEST RECORDS QR 2009, QR 2010 AND QR 2011

Delivered in boxes of five

Diameter:

301,6 mm (11,875 in)

Diameter of Centre Hole:

7,3 mm (0,287 in)

Speed of Rotation:

QR 2009: 45 rev./min.

QR 2010: 33 1/3 rev./min.

QR 2011: 33 1/3 rev./min.

Cutting Angle:

QR 2009: 0°

QR 2010: 20°

QR 2011: 15°

Program and Accuracy:

See scheme page 7

Recording Characteristics:

In accordance with IEC, RIAA, NAB, BS and DIN recommendations and standards. QR 2009 and QR 2010 are recorded with constant velocity above 1 kHz (No treble emphasis, see text)

Broad-band and Surface Noise:

More than 32 dB below ref. level

QR 2009

More than 45 dB below ref. level

QR 2010

More than 45 dB below ref. level

QR 2011

Increased to 65, 75 and 75 dB respectively below ref. level by filtering through 1/3 octave filters

*) If the instrument is placed in a 50 Hz magnetic field of 100 A/m this figure is increased to $<$ 10 μ V. All other specifications are unchanged