Technical Documentation

Power Amplifier Type 2719

User Manual

Brüel & Kjær

English BE 1660 – 12

Power Amplifier Type 2719

User Manual

BE 1660 – 12

May 2006

Safety Considerations

This apparatus has been designed and tested in accordance with IEC 61010 – 1 and EN 61010 – 1 *Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use*. This manual contains information and warnings which must be followed to ensure safe operation and to retain the apparatus in safe condition. Special note should be made of the following:

Safety Symbols

The apparatus will be marked with this symbol when it is important that you refer to the associated warning statements given in the manual.

Protective Earth Terminal Hazardous Voltage

Explosion Hazard

The equipment is not designed to be used in potentially explosive environments. It should not be operated in the presence of flammable liquids or gases.

Warnings

- Whenever it is likely that the correct function or operating safety of the apparatus has been impaired, it must be made inoperative and be secured against unintended operation.
- Any adjustment, maintenance and repair of the open apparatus under voltage must be avoided as far as possible and, if unavoidable, must be carried out only by trained service personnel.

- Do not dispose of electronic equipment as unsorted municipal waste
- It is your responsibility to contribute to a clean and healthy environment by using the appropriate local return and collection systems
- Hazardous substances in electronic equipment may have detrimental effects on the environment and human health
- The symbol shown to the left indicates that separate collection systems must be used for any discarded equipment marked with that symbol
- Waste electrical and electronic equipment may be returned to your local Brüel & Kjær representative or to Brüel & Kjær Headquarters for disposal

Trademarks

Neutrik and **Speakon** are registered trademarks of Neutrik AG.

Table of Contents

CHAPTER 1
Introduction **1**

CHAPTER 2
Controls **3**
Front Panel 3
Back Panel 4

CHAPTER 3
Operation **5**
Preliminary 5
System Checks and Connections 5

CHAPTER 4
Characteristics **11**
Signal Inputs 11

CHAPTER 5
Specifications **17**

CHAPTER 6
Service and Repair **19**

Chapter 1

Introduction

Power Amplifier Type 2719 has been designed to drive small vibration exciters, particularly the 112 N (25 lbf) Vibration Exciter Type 4808. The RMS output-current limit is adjustable, and consequently Type 2719 can drive the 45 N (10 lbf) Vibration Exciter Type 4809 safely to full rating. The power amplifier has a usable frequency range from DC to 100 kHz. The rated AC output is 180 VA into a 0.8 Ω exciter or resistive load, in the frequency range DC to 15 kHz (± 0.5 dB). The maximum voltage gain is 40 dB. Harmonic content of the output is very small as heavy negative feedback is used and the instrument can tolerate temperature and supply line variations while maintaining excellent stability.

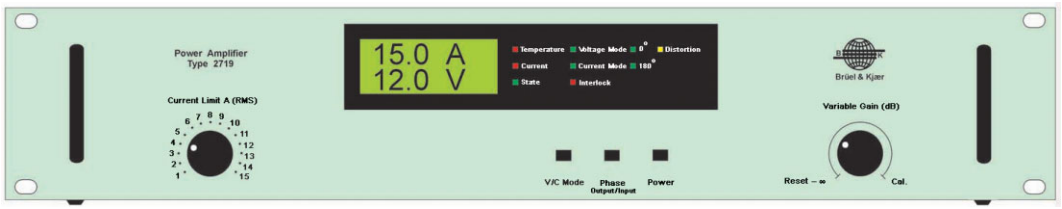
Type 2719 can be used as a voltage generator with low output impedance and a flat voltage frequency response, or as a current generator with high output impedance and a flat current frequency response.

Chapter 2

Controls

Front Panel

Fig. 2.1 *Front panel of Type 2719*



Current Limit A (RMS): A single-turn potentiometer for limiting RMS current output.

Display: The display shows output AC current and voltage on a LCD display.

- The **Temperature** LED indicator lights red if the Power MOS Output Transistors overheat. The amplifier then shuts-down
- The **Current** LED indicator lights red when output current to the load is exceeding the Current Limit value set. The amplifier then shuts-down
- The **State** LED indicator lights green when the amplifier power is switched On
- The **Voltage** or **Current Mode** LED indicator lights green showing the output mode
- The **Interlock** LED indicator lights red when the interlock circuit is activated
- The **0°** or **180°** LED indicator lights green indicating phase shift from input to output
- The **Distortion** LED indicator lights yellow when output voltage or current clipping occurs

V/C Mode: Select feedback and output impedance modes. The positions are:

Voltage Mode: Provides constant voltage characteristics independent of changes of test object on the exciter. Gives the best acceleration waveform and is therefore preferable for most vibration tests.

Current Mode: Provides constant current characteristics, keeping the generated force independent of changes of test object.

Phase: Set the phase shift, output/input, 0 or 180 degrees. A green lit LED lamp indicates the phase shift the amplifier is set.

Power: Mains On/Off button.

Variable Gain (dB): Single-turn, logarithmic potentiometer for continuous adjustment of input signal level. To prevent a power surge, turn the knob fully anticlockwise for maximum attenuation before switching the power on or off. Turning the knob fully anticlockwise till it clicks and back again activates Reset.

Back Panel

Fig. 2.2 *Back panel of Type 2719*

Signal Input AC: BNC socket providing a capacitive-coupled input to the amplifier. The –0.5 dB lower limiting frequency is 15 Hz. Full output is produced by a 2.4 V RMS input signal.

Signal Input DC: BNC socket providing a direct-coupled input to the amplifier. It enables a DC offset voltage to be applied for centring the exciter's vibration table when it is statically offset by a heavy test object. The input impedance is >10 kΩ. Full output is produced by a 2.4 V RMS input signal.

Voltage Monitor: BNC socket providing output of the amplifier voltage waveform (including DC component) for display on an oscilloscope. The monitor signal is the amplifier output voltage attenuated 20 dB or 0.1 V/V.

Current Monitor: BNC socket providing output of the amplifier output waveform (including DC component) for display on an oscilloscope. The monitor signal is the amplifier output current in 0.1 V/A.

Output: Power output Neutrik® Speakon® socket accepting a 4-pin Neutrik® Speakon® plug or connecting cable provided for connection of an exciter (see "Output Connections" on page 5). For a full power output of 180 VA, the moving coil of the exciter or load should have a nominal load impedance of 0.8 Ω.

Mains Voltage Selector and Fuse: Voltage selector for operation of the amplifier from a 100, 120, or 230 V ±10% (50 to 60 Hz) single phase, AC mains supply. To select the correct voltage setting or to change the fuse, see "Mains Supply Connections" on page 6.

Mains Input: Input socket accepting the power cable provided. For connection of a mains supply, see "Mains Supply Connections" on page 6.

Chapter 3

Operation

Preliminary

Environment

Power Amplifier Type 2719 is designed for operation at ambient temperatures between 5 and 40°C (41 to 104°F). Operation at full power will cause the Power MOS Output Transistors' heat sink to heat up. This is normal. However, it is important to ensure a free flow of cooling air through the input vent in the top cover to the output vent in the back panel, otherwise the input drive signal will be automatically blocked and Type 2719 will shut down to prevent overheating of the transistors.

Rack Mounting

Power Amplifier Type 2719 is designed to fit into 19″ standard rack system. It may be used free standing on its four rubber feet, however, when fitted in a instrumentation rack, the rubber feet must be removed.

System Checks and Connections

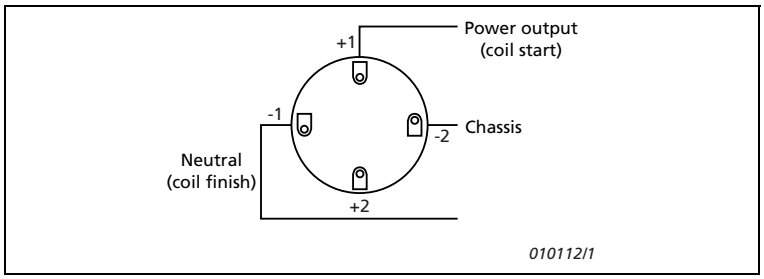
Before connecting a mains supply, the following system checks and connections should be carried out to ensure the correct function and safe operation of the apparatus.

⚠ **WARNING:** Disconnect all power from the amplifier before removing or replacing its protective panels. Internal adjustments with mains power connected should only be carried out by skilled persons who are aware of the hazards of dealing with live circuitry.

Output Connections

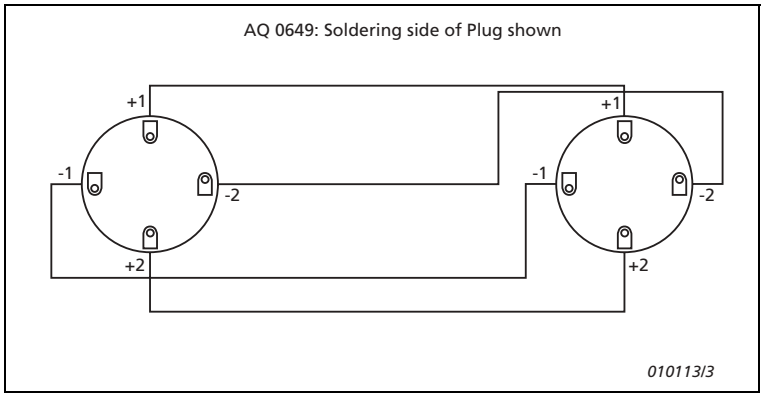
The amplifier's Output socket (on back panel) accepts a 4-pin Neutrik® Speakon® plug. The pin connections are shown in Fig. 3.1.

Fig. 3.1
Type 2719 Output socket



Use the drive cable provided with the exciter to connect. Match the numbering on the plug and socket to connect.

Fig. 3.2
Connecting the amplifier to the modal exciter using the exciter's drive cable



Mains Supply Connections

Mains Voltage Setting

Type 2719 can be powered from a 100 V, 120 V or 230 V ±10% (50 to 60 Hz), single-phase AC mains supply. To select the correct mains voltage setting, use a small screwdriver to remove the voltage selector with integrated fuse holder from the combined voltage selector and mains power inlet, then put it back again so that the white dot on the amplifier unit is aligned with the appropriate voltage printed on the selector.

Fuse Check and Replacement

The mains fuse and fuse holder are integrated in the voltage selector. It can be released using a screwdriver. For 100 V and 120 V operation, the fuse should be a T6.3 A slow blow, whilst for 230 V operation it should be a T3.15 A slow blow. Make sure that only fuses of the required rated current and of the specified type are used for replacement. Do not use mended fuses or short-circuit the fuse holder.

Mains Socket Connection

Once the mains voltage setting and fuse are correct, use the power cable provided to connect the mains to the mains input socket of the amplifier. Note that for maximum operating safety

the protective (green/yellow) conductor of the cable should be connected to a suitable earth, such as the earth contact of a mains outlet socket. The use of an extension cable without protective conductor should be avoided for safety reasons.

In countries where use of mains socket outlets without protective conductor is standard, the mains supply should incorporate an authorized earth leakage current circuit breaker.

Grounding Considerations

The signal ground line of Type 2719 is permanently connected to its chassis. This is done at one point only to give the best possible immunity to mains-carried noise. Nevertheless, when using the amplifier in complex measurement setups, indiscriminate grounding of the instrument signal ground lines may introduce mains hum. This can be avoided by ensuring that the signal ground line of the entire measurement setup is grounded at one point only. To do this without prejudicing the operating safety of the instruments involved:

1) Connect the signal ground lines of all instruments together. This is done automatically through the screens of the input and output cables used to interconnect the instruments.

2) If instruments equipped with a mains socket protective earth terminal are employed in the measurement arrangement then check that:
   a) one and only one of these instruments has its signal ground line connected via chassis to mains ground
   b) the housing of the measurement transducer is isolated from measurement objects

3) If the measurement arrangement is used free-standing without instrument cabinets touching, then ensure that the method in which to connect the signal ground line for each instrument in the measurement arrangement is consistent – either each one is connected to the mains ground, or each is connected to its chassis. Mains ground is preferred for instruments with a mains socket chassis terminal.

4) If the measurement arrangement is mounted in a metal instrumentation rack, then ensure that one and only one of the instruments has its signal ground line connected to chassis (and chassis connected to mains ground if equipped with mains socket chassis terminal). If more than one of the instruments has a permanent signal ground chassis connection, then isolate the chassis of these instruments from one another.

Operating Procedure

After making the system checks and connections described in "System Checks and Connections" on page 5, use the following procedure to commence operation:

1) Set the amplifier controls as shown below:

Power:	**Off**
Variable Gain (dB):	Fully anticlockwise, but do not **Reset**
Current Limit A (RMS):	Maximum current limit of the exciter's moving coil. Consult the manufacturer's data for the exciter in use.
V/C Mode:	Select **Voltage Mode** for the best acceleration waveform or **Current Mode** for force related tests. See "Power Output" on page 12.

2) Connect the output of a signal generator to the AC or DC input on the back panel of the amplifier.

3) On the power amplifier set:

Power:	**On**. The State, Mode and Phase LEDs in the display unit will light up green.
Variable Gain (dB):	Fully clockwise to **Cal.** position

4) Set the generator to the required frequency. Then slowly increase the output voltage until the vibration table reaches the required level of vibration. With setups where the vibration level is controlled by a feedback circuit, the voltage level will be increased automatically.

   If the amber **Distortion** lamp lights or the maximum displacement limit of the vibration exciter is exceeded, causing the vibration table to knock against its end-stops, reduce the generator output voltage to a lower level in order to resume operation.

   For frequency sweep vibration testing, adjust the generator to the lowest frequency of interest to check that the exciter's low frequency limit is not exceeded.

5) To set the amplifier to stand-by during a test, turn the Variable Gain (dB) to **Reset**. At the end of the test, always put the amplifier on stand-by before switching the Power **Off**.

Warning Lamps and Fault Detection

If one of the red warning lamps lights, a fault has occurred in the system. Under such circumstances, the amplifier automatically stops to protect the amplifier and vibration exciter. To help establish the cause of the shut-down, some probable faults are given in the table below.

Warning Lamp	Probable Fault
Current	Input drive level too high for **Current Limit A (RMS)** setting
	Wrong output connections to exciter
Temperature	Overdrive at low frequencies
	Wrong output connections to exciter
	Vibration laboratory temperature too high
	Forced air cooling system of amplifier blocked

If incorrect amplifier control settings or exciter connections cause shut-down, turn the Variable Gain (dB) to **Reset** and make the necessary adjustments. Normal operation can then be resumed by returning Variable Gain (dB) to the position used for test.

If a shut-down is caused by an internal fault in the amplifier or exciter, stop the test by setting Variable Gain (dB) to **Reset** and switch the amplifier off. Then consult your Brüel & Kjær service representative.

Chapter 4

Characteristics

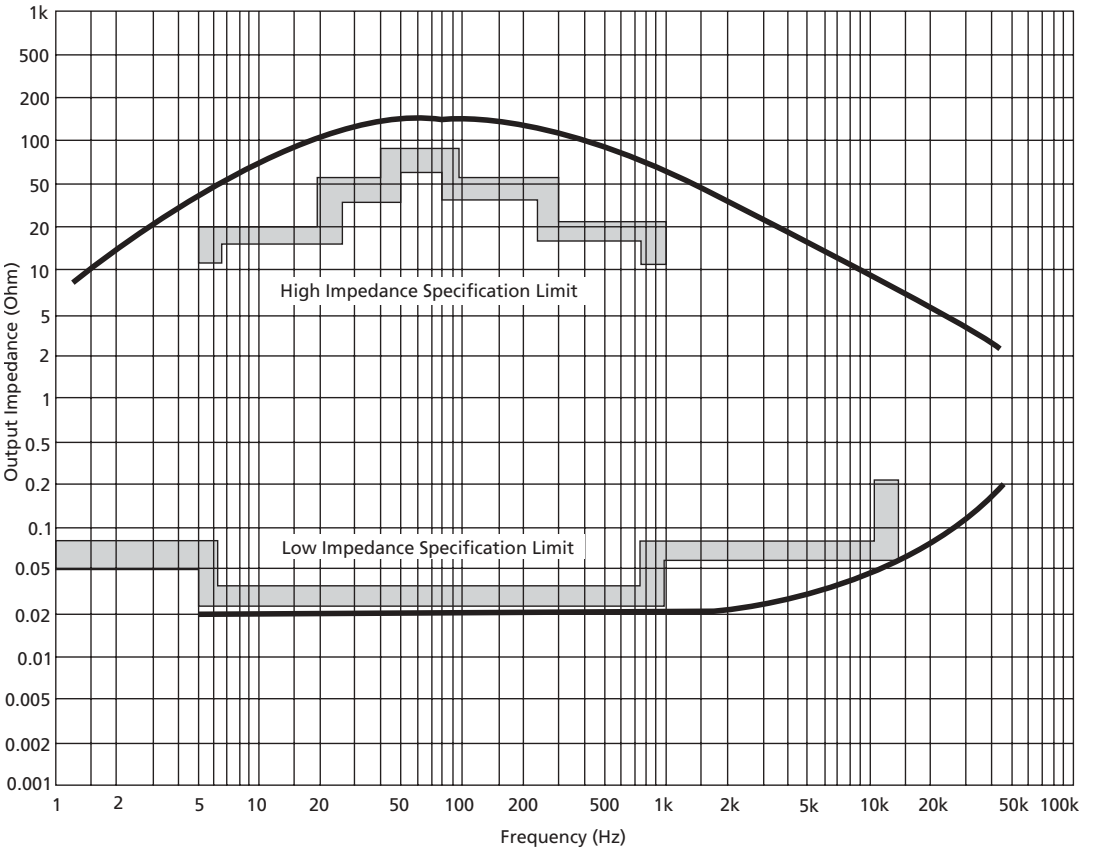
Signal Inputs

The signal inputs of Type 2719 have a minimum input impedance of 10 kΩ. The AC signal input is for connecting a vibration exciter controller or generator and is capacitive-coupled giving a −0.5 dB lower limiting frequency of approximately 15 Hz. The DC signal input is direct-coupled enabling a DC offset voltage to be applied for centring vibration exciter tables, which are statically displaced by heavy test objects.

The maximum input voltage for both inputs is 3.4 V peak. At higher input levels, the drive signal is clipped causing the Distortion lamp to light.

Power Output

Fig.4.1 *Output impedance of Type 2719 as a function of frequency and V/C Mode switch setting*



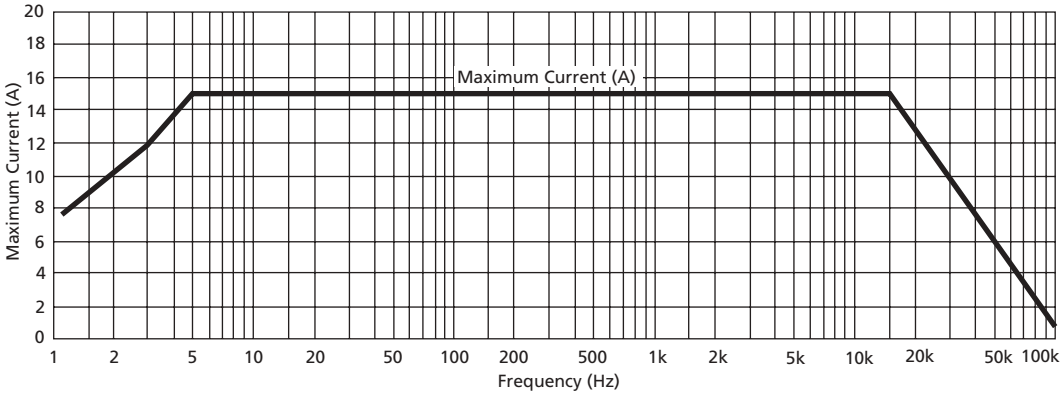
010101

The power output of Type 2719 is direct-coupled. Its output impedance, shown in Fig.4.1, depends on the feedback setting selected using the V/C Mode switch.

In **Voltage Mode** (low impedance), a fraction of the voltage developed across the moving coil of the exciter is used as feedback. This gives the amplifier constant voltage characteristics – very low output impedance and constant output voltage with frequency – producing the best acceleration waveform. It is, therefore, suited to most single-exciter applications as well as to multiple-exciter applications at low frequencies where it is important that the exciters have the same motion.

In **Current Mode** (high impedance), feedback is proportional to the current flowing in the exciter's moving coil. This gives the amplifier constant current characteristics – high output impedance and constant output current with frequency – necessary to obtain a constant force with the exciter regardless of changes in the test object. This is useful for single-exciter fatigue tests and multiple-exciter resonant mode studies of vibration test objects.

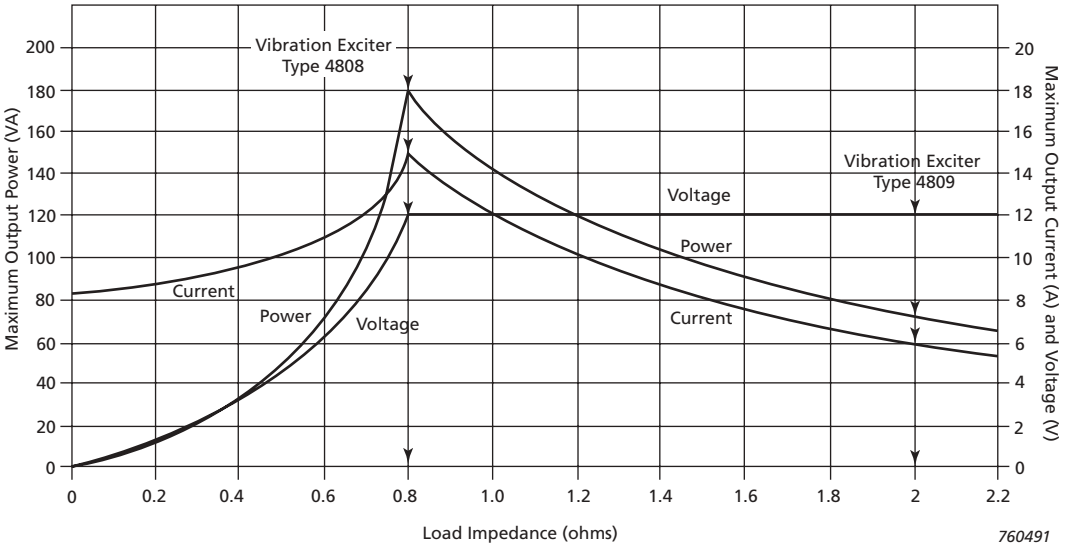
Fig.4.2 *Maximum output current rating of Type 2719 as a function of frequency*



010102

As shown in Fig.4.2, the maximum output current is frequency-dependent. The maximum power output is 180 VA, which is obtained using exciters with a nominal load impedance of 0.8 Ω. For other exciter load impedances, the maximum output rating is as shown in Fig.4.3. This is valid at frequencies, from 5 Hz to 15 kHz. At other frequencies, the amplifier's output rating must be derated in accordance with Fig.4.2.

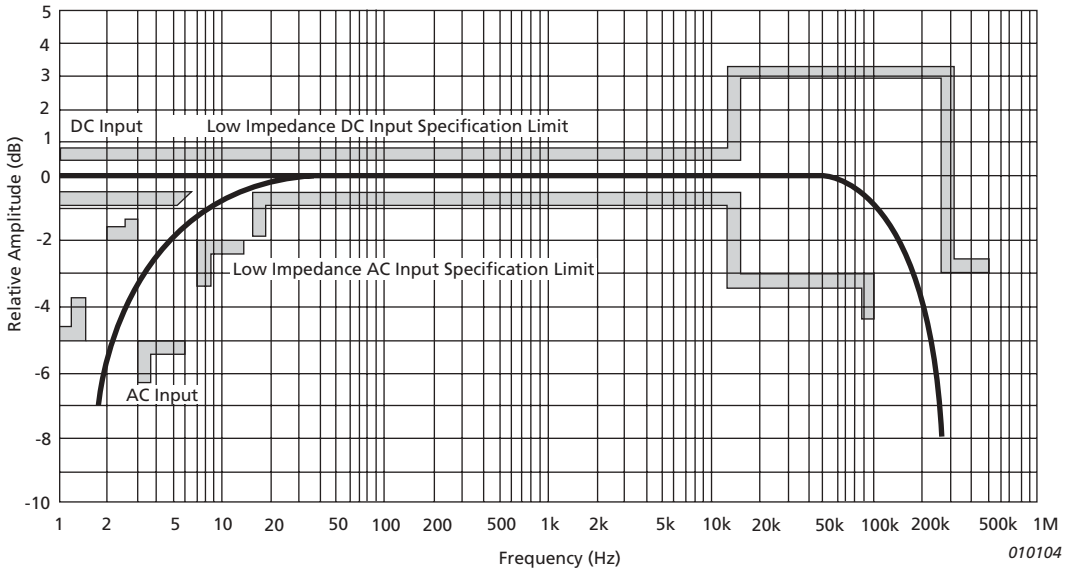
Fig. 4.3 *Maximum output voltage, current and power output ratings of Type 2719 as a function of exciter load impedance, valid at frequencies from 40 Hz to 10 kHz*



Frequency Response

The full power output of 180 VA is available in the frequency range from 40 Hz to 10 kHz. At lower power levels the amplifier has a useful frequency range from DC to 100 kHz. This depends on the signal input socket used and the setting of the V/C Mode switch, as shown by the response curves for small signals given in Fig.4.4.

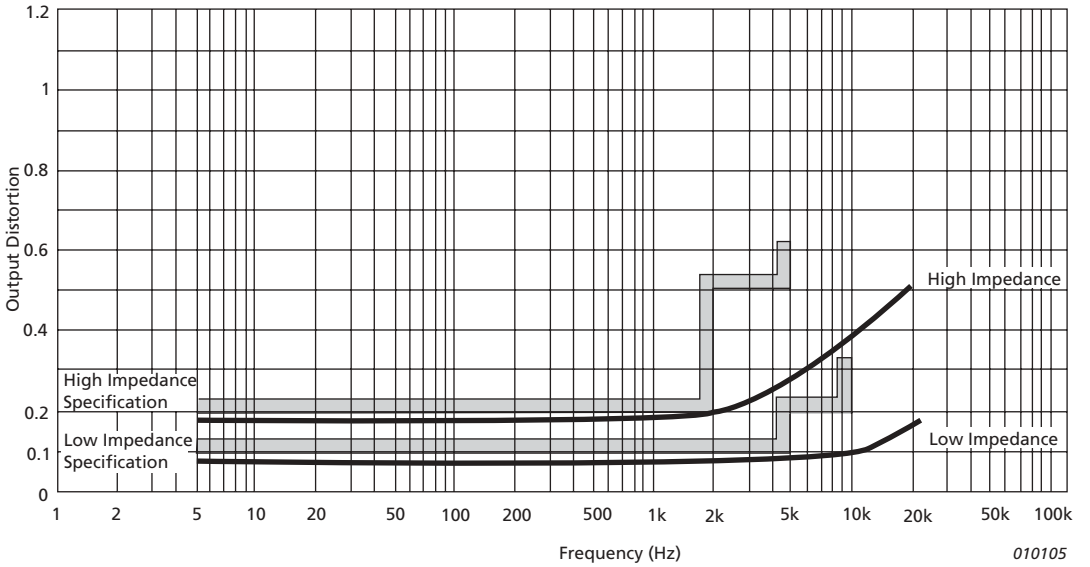
Fig.4.4 *Frequency response in Voltage Mode of Type 2719 for power output levels up to 20 VA*



Distortion

The percentage of harmonic distortion produced by Type 2719 is shown in Fig. 4.5. Considering the 180 VA power output rating of the amplifier, the amount of distortion is very low. This can be attributed to the generous amount of feedback applied and the use of a direct-coupled input.

Fig. 4.5 *Typical harmonic distortion percentage curves for Voltage Mode and Current Mode output impedance – 180 VA in a 0.8 Ω load*



Chapter 5

Specifications

COMPLIANCE WITH STANDARDS

CE compliance with EMC Directive

compliance with EMC Requirements of Australia and New Zealand

Safety, EMC Emission and Immunity: According to relevant standards:
EN/IEC 61010–1, UL 61010–1,
EN/IEC 61000–6–2, EN/IEC 61000–6–4, CISPR22 Class A limit, FCC Rules Part 15, EN/IEC 61326
Temperature: According to IEC 60068–2–1 and IEC 60068–2–2
Operating temperature:
+5 to +40°C (41 to 104°F)
Storage temperature:
–25 to +70°C (–13 to 158°F)
Humidity: According to IEC 60068–2–78, Damp Heat: 90% RH (non-condensing at 40°C (104°F))
Mechanical: Non-operating according to IEC 60068–2–6, IEC 60068–2–27, IEC 60068–2–29
Reliability: According to MIL–HDBK217 F, GB (Part-stress)
Enclosure: Protection according to IEC 60529

POWER OUTPUT CAPACITY
180 VA into a 0.8 Ω exciter or resistive load, at 25°C and nominal mains voltage.
144 VA into a 1 Ω exciter or resistive load, at 40°C or at 10% above nominal mains voltage.
(4-pin Neutrik® Speakon® socket at rear panel)

OUTPUT VOLTAGE CAPACITY
12 V RMS, DC to 15 kHz, via 4-pin Neutrik® Speakon® plug

OUTPUT CURRENT CAPACITY
7.5 A RMS at or below 5 Hz
15 A RMS, 40 Hz to 10 kHz
12 A RMS at 15 kHz

FREQUENCY RANGE
Full Capacity: 40 Hz to10 kHz
Reduced Capacity: DC to 100 kHz

FREQUENCY RESPONSE
Typical small signal response in low impedance mode:
DC Input: DC to 15 kHz ±0.5 dB; DC to 100 kHz ±3 dB
AC Input: 15 Hz to 15 kHz ±0.5 dB
(2 separate BNC sockets at rear panel)

INPUT IMPEDANCE
>10 kΩ

DC STABILITY
Less than 50 mV drift from 0 V for ±10% variation of mains supply from nominal, and for 10°C to 40°C (50°F to 104°F) variation in ambient temperature

CONTROLS
Power on/off
Continuously variable gain control, 0 to Cal. (14 dB) with integral reset
Continuously variable current limit control 1 to 15 A (RMS)
Switch for voltage mode or current mode operation
Switch for phase inversion (0° or 180°) between input and output

MULTIFUNCTION DISPLAY (LCD) AND INDICATOR LAMPS
Clipping
Temperature overload
Current overload
Power on
Ready
Voltage mode
Current mode
Interlock
AC mode
DC mode
Stand-by
RMS Voltage Monitor – for approximate indication (also available from BNC connector at back panel with read-out accuracy ±2%)

RMS Current Monitor – for approximate indication (also available from BNC connector at back panel with read-out accuracy ±2%)

PROTECTION

Input signal is removed and an indicator lamp is lit when the following parameters exceed preset limits:
Driver Coil Current – true RMS adjustable limit 1 to 15 A (RMS)
Power Transistor Temperature
Heat Sink Temperature
Output Signal Distortion – no shut down

OTHER FEATURES

Electronic peak current limiting

POWER REQUIREMENTS

Single phase 100, 120, 230 V RMS, ±10%. Approx. 400 VA at full load
Power insert connector with fuse holder and voltage selector at rear panel

DIMENSIONS

Height: 2HE equivalent of 88 mm
Width: 482.6 mm (19 in) with flanges for standard 19- inch rack mounting
Depth: 350 mm (13.8 in)

WEIGHT

14.0 kg (31 lb.)

Chapter 6

Service and Repair

Type 2719 is designed and constructed to provide many years of safe, reliable operation. However, if the correct function or operating safety of the instrument is impaired, immediately disconnect it from the mains source and secure it against unintended operation. For repair contact your local Brüel & Kjær representative. Under no circumstances should repair be attempted by persons not qualified in the service of electronic instrumentation.

⚠ **WARNING:** Disconnect all power from the amplifier before removing or replacing its protective panels. Internal adjustments with mains power connected should only be carried out by skilled persons who are aware of the hazards of dealing with live circuitry.

HEADQUARTERS: DK-2850 Nærum · Denmark · Telephone: +45 4580 0500 · Fax: +45 4580 1405 · www.bksv.com · info@bksv.com

Australia (+61) 2 9889-8888 · Austria (+43) 1 865 74 00 · Brazil (+55) 11 5188-8161 · Canada (+1) 514 695-8225
China (+86) 10 680 29906 · Czech Republic (+420) 2 6702 1100 · Finland (+358) 9-521 300 · France (+33) 1 69 90 71 00
Germany (+49) 421 17 87 0 · Hong Kong (+852) 2548 7486 · Hungary (+36) 1 215 83 05 · Ireland (+353) 1 807 4083
Italy (+39) 0257 68061 · Japan (+81) 3 5715 1612 · Netherlands (+31) 318 55 9290 · Norway (+47) 66 77 11 55
Poland (+48) 22 816 75 56 · Portugal (+351) 21 41 69 040 · Republic of Korea (+82) 2 3473 0605 · Singapore (+65) 6377 4512
Slovak Republic (+421) 2 5 443 0701 · Spain (+34) 91 659 0820 · Sweden (+46) 33 225 622 · Switzerland (+41) 44 880 7035
Taiwan (+886) 2 2502 7255 · United Kingdom (+44) 14 38 739 000 · USA (+1) 800 332 2040

Local representatives and service organisations worldwide