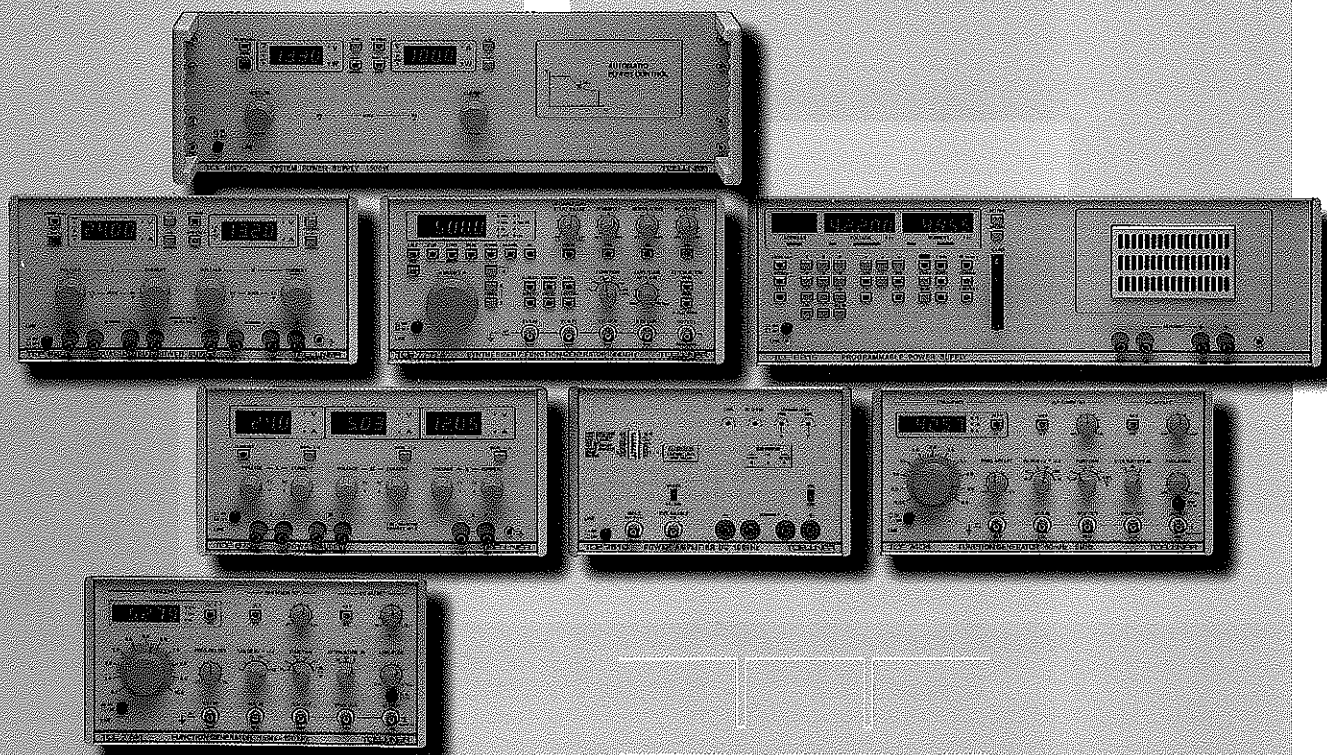


# TOELLNER®

Bedienungsanleitung  
Vierquadranten-  
Verstärker

Instruction Manual  
Four-Quadrant  
Amplifier

TOE 7610

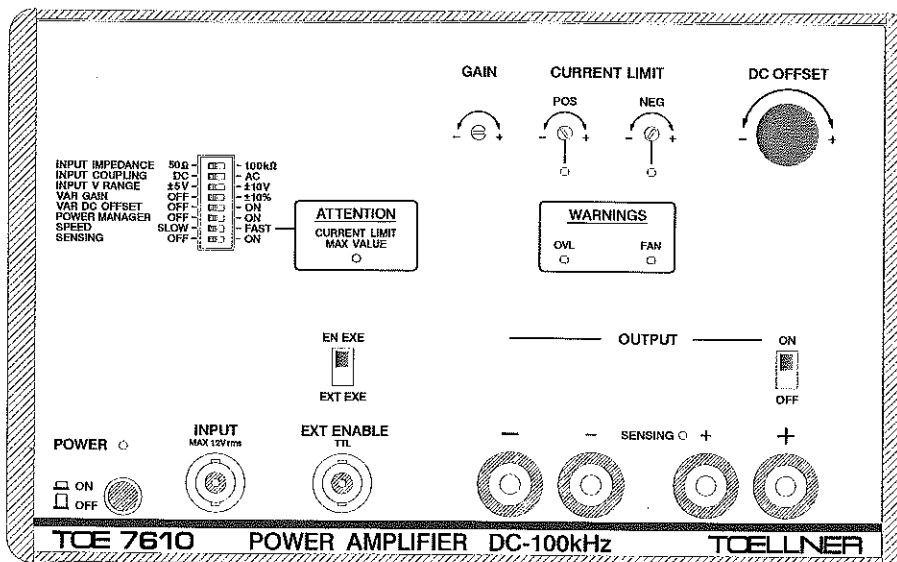


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TOE 7610

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# TOELLNER®

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Technische Änderungen vorbehalten

Technical modifications reserved

## Deutsch

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## English

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### Warnung

Dieses Gerät ist gemäß EN 61010-1, "Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel- und Laborgeräte", gebaut und geprüft und hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen und entspricht der Schutzklasse I. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muss der Anwender unbedingt die Hinweise und Warnvermerke beachten, die in dieser Bedienungsanleitung enthalten sind.

**Beim Betrieb elektrischer Geräte stehen zwangsläufig bestimmte Teile dieser Geräte unter gefährlicher Spannung. Bei Nichtbeachten der Warnvermerke können deshalb schwere Körperverletzungen oder Sachschäden auftreten.**

Nur entsprechend qualifiziertes Personal sollte an diesen Geräten oder in deren Nähe arbeiten. Der einwandfreie und sichere Betrieb dieser Geräte setzt sachgemäßen Transport, fachgerechte Lagerung, Aufstellung sowie sorgfältige Bedienung und Instandhaltung voraus.

*Qualifiziertes Personal* im Sinne dieser Bedienungsanleitung sind Personen, die mit Aufstellung, Inbetriebsetzung und Betrieb der Geräte vertraut sind und über die ihrer Tätigkeit entsprechenden Qualifikationen verfügen.

### Warning

This device has been built and tested in line with EN 61010-1, "Safety directives for electrical measuring, control and laboratory equipment", and left the factory in a perfectly safe state, complying with protection class I. In order to retain this state and to guarantee operation free of danger, it is essential for users to observe the notes and warnings present in this Instruction Manual.

**When using electrical equipment, certain parts are subject to dangerous voltages. Failure to observe the warnings could therefore result in severe personal injury or damage to property.**

Only appropriately qualified personnel should work on these devices or in their vicinity. Correct and safe operation of these devices is dependent on proper transport, storage and installation, as well as careful operation and maintenance.

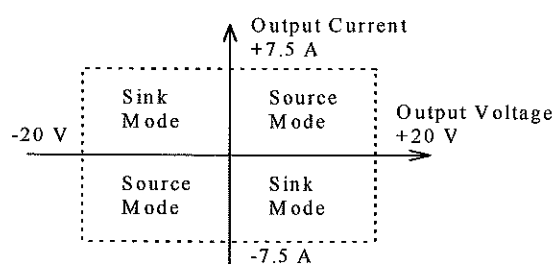
*Qualified personnel* in the sense of this Instruction Manual are persons who are acquainted with the installation, commissioning and operation of the devices, possessing qualifications appropriate to the job.

## 1. General

### 1.1 Introduction

Power supplies for laboratory use are mostly only power sources. They are only able to deliver power with one single polarity, but cannot work as a power sink. These instruments only work in one quadrant of the output voltage/current diagram. Common amplifiers deliver output voltages with both polarities, but are generally unable to absorb power values in a range comparable to that which they are able to deliver. They therefore mainly work in two quadrants of the output voltage/current diagram. The four-quadrant amplifier **TOE 7610** is able to work as a power sink as well as a power source with equal values of delivered or absorbed power. It combines amplifier, bipolar voltage and current source, and sink in one instrument.

As an amplifier for combination with other drivers, it can work together with many different types of voltage source. Versatile access to the preset amplifier settings permits optimum adaptation of the four-quadrant amplifier **TOE 7610** to the respective conditions of its wide range of applicability.



Four-quadrant mode of the **TOE 7610-20**

### 1.2 Features

The four-quadrant amplifier **TOE 7610** is available in different voltage and current designs. The voltage designation is identified by a number added to the type designation and separated by a hyphen. The maximum current values are listed in the following table.

Model	Output voltage $V_{max}$	Output current $I_{max}$	Output power $P_{max}$
<b>TOE 7610-10</b>	±10 V	±15 A	150 W
<b>TOE 7610-20</b>	±20 V	±7.5 A	150 W
<b>TOE 7610-40</b>	±40 V	±4 A	160 W
<b>TOE 7610-60</b>	±60 V	±2.5 A	150 W

A selectable power manager ensures that the maximum output power  $P_{max}$  can also be processed as a permanent sink value \*. Numerous possible settings for the four-quadrant amplifier allow it to be optimally connected to the preceded driving device, whether this is a laboratory power supply, a calibrator or a signal source such as e.g. a function generator.

The most important settings of the four-quadrant amplifier **TOE 7610** are the DC or AC voltage input coupling, the selectable input impedance, the selectable gain with a variation range of ±10 % and the addition of a DC offset voltage at the output.

Selection between *FAST* mode and *SLOW* mode permits adaptation of the device response to signal processing or power supply applications. Separate settings for output current limits with both polarities permit use of the four-quadrant amplifier **TOE 7610** e.g. for charging and discharging cycles of accumulators. Four-wire mode can be selected in addition. Finally, the output of the amplifier can be switched in different manners to a high-impedance off state.

\* not available for **TOE 7610-10**

## 2. Operation

### Warning

Safe operation of these devices depends on them being started up by qualified personnel with observation of the warnings in this Instruction Manual.

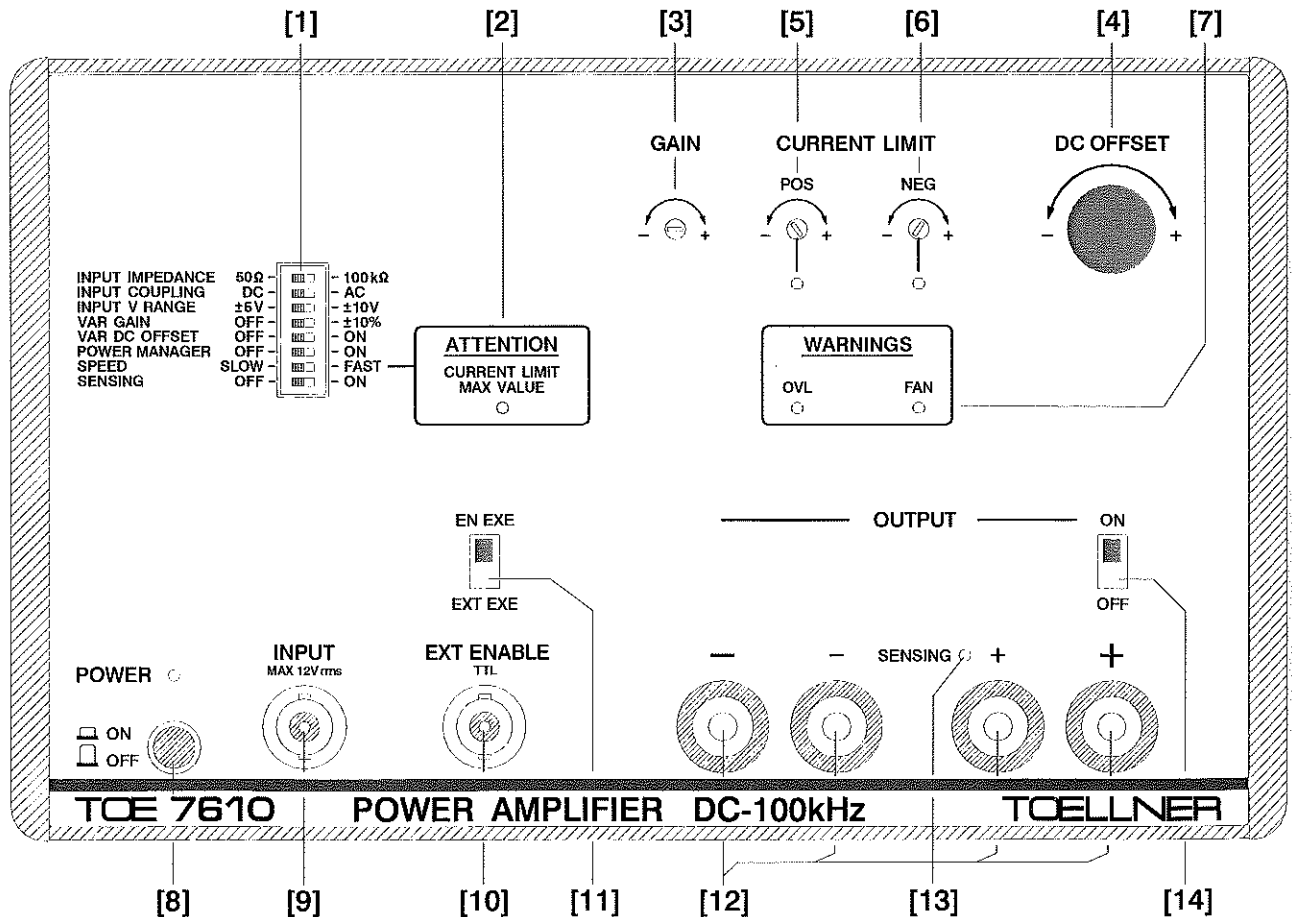
The general directives for installation and safety (e.g. DIN/EN and VDE) must be observed in particular. The failure to observe these directives could result in death, severe personal injury or substantial damage to property.

These devices comply with protection class I (protective earth connection) according to EN 61010-1. Before switching on, make sure that the operating voltage set on the device agrees with the local mains voltage (→ rating plate 230 V/115 V ±10 %, 48 - 65 Hz). Except when used in rooms with particular protective measures, the mains plug must only be inserted into a socket with PE contact. The protective earth effect must not be cancelled by using an extension cord without PE conductor. The mains plug must be inserted into the socket before the device is switched on and before the measuring and control circuits are connected. Any interruption in the PE conductor inside or outside the device, or loosening of the PE conductor connection, could make the device dangerous. An intentional interruption in the PE conductor connection is not permissible. The local directives concerning grounding must be observed.

Make sure that only fuses of the specified type and rated current are used as replacements (→ 3. Technical specifications). The use of repaired fuses or the short-circuiting of the fuse holder is not permissible.

If it can be assumed that operation free of danger is no longer possible, the devices must no longer be used, and must be protected against unintentional use.

### 2.1 Front panel view



Front panel view of the four-quadrant amplifier TOE 7610

## 2.2 Description of controls

Refer to the front panel view (→ 2.1) of the four-quadrant amplifier **TOE 7610** for further use of the device. The individual controls are described below in detail.

- [1] Switch assembly for amplifier configuration  
The programming switches on the front panel permit the following default settings:
- [1.1] *INPUT IMPEDANCE 50 Ω / 100 kΩ*  
Permits selection of the DC input impedance as 50 Ω or approx. 100 kΩ. With an input impedance of 50 Ω, the maximum permissible input voltage is 12 V<sub>rms</sub> irrespective of the input coupling.
- [1.2] *INPUT COUPLING DC/AC*  
Permits selection of either DC or AC input coupling. With a 50 Ω input impedance, the DC input impedance remains approx. 50 Ω even with AC coupling; with a 100 kΩ input impedance and AC coupling, the DC input impedance becomes infinite. The lower limit frequency for AC coupling is approx. 2 Hz.
- [1.3] *INPUT V RANGE ±5 V / ±10 V*  
Sets the input voltage to either 5 V or 10 V as required for the rated output voltage.
- [1.4] *VAR GAIN OFF / ±10 %*  
When activated, permits variation of the operational gain by up to ±10 %. The setting is made using the adjuster *GAIN* [3].
- [1.5] *VAR DC OFFSET OFF/ON*  
When activated, permits a DC offset at the output up to the maximum values of the output voltage. The setting is made using the adjuster *DC OFFSET* [4].
- [1.6] *POWER MANAGER OFF/ON \**  
In sink mode, the activated power manager allows power saving operation of the amplifier. The permissible sink power  $P_{\max}$  in permanent operation is thus guaranteed.
- [1.7] *SPEED SLOW/FAST*  
In *SLOW* mode, the amplifier permits operation with limited currents where the maximum output currents can be set separately for each polarity. The adjusters *CURRENT LIMIT POS* [5] and *CURRENT LIMIT NEG* [6] are used for this purpose. The currents can be set from 0 ...  $I_{\max}$  and 0 ...  $-I_{\max}$  respectively. If the amplifier enters the respective limiting mode, the LED lights up underneath the corresponding adjuster. The large-signal bandwidth of the amplifier is approx. 30 kHz in *SLOW* mode. In *SLOW* mode, the amplifier is also stable with purely capacitive loads up to 100 μF.  
  
In *FAST* mode, an enlarged slew rate results in a large-signal bandwidth of 100 kHz. In contrast to *SLOW* mode, the output current limiting is deactivated in this case. As a warning, the *FAST LED* [2] lights up next to the *FAST* position of the switch. However, a fixed current limiting function to protect the circuit limits the current to  $I_{\max}$ .
- [1.8] *SENSING OFF/ON*  
When activated, permits four-wire mode of the amplifier. An illuminated LED next to the word *SENSING* above the output sockets [12] indicates that four-wire mode is activated. This mode is only recommended for the *SLOW* mode.
- [2] *FAST LED*  
Lights up in *FAST* mode and signals that the adjustable current limiting is not active. Instead of this, the output current is limited slightly above the maximum rated currents of 7.5 A.
- [3] *GAIN* adjuster  
The preset gain can be varied by ±10 % using a screwdriver if the switch *VAR GAIN* [1.4] is set to *ON*.

\* For the TOE 7610-10 the function *POWER MANAGER ON* is not available. The permissible sink power  $P_{\max}$  is not guaranteed in permanent operation. However, with the internal temperature control the device stays safe in operation. In the case of overtemperature an external power source at the output will be cut off.

- [4] **DC OFFSET control**  
A DC voltage component is added to the output signal if the switch *VAR DC OFFSET* [1.5] is set to *ON*. The magnitude of this component can be set by the potentiometer *DC OFFSET*. The range of variation extends from the maximum negative output voltage up to the maximum positive output voltage. The total of the added DC voltage component and the voltage resulting from the input signal should not exceed the maximum output amplitudes. Signal distortions must otherwise be expected.
- [5] **CURRENT LIMIT POS adjuster**  
The adjustable current limiters are active in *SLOW* mode. Using a screwdriver, the maximum positive output current can be set between 0 ...  $+I_{max}$  on the adjuster *CURRENT LIMIT POS*. The LED underneath the adjuster lights up if the amplifier is subject to positive current limiting.
- [6] **CURRENT LIMIT NEG adjuster**  
The adjustable current limiters are active in *SLOW* mode. Using a screwdriver, the maximum negative output current can be set between 0 ...  $-I_{max}$  on the adjuster *CURRENT LIMIT NEG*. The LED underneath the adjuster lights up if the amplifier is subject to negative current limiting.
- [7] **Warnings**  
A display field with the following warnings is located underneath the adjusters:
- [7.1] **OVL warning**  
The *OVL* LED lights up if the temperature of the heat sink exceeds the maximum permissible value. This information is stored, and the output of the amplifier is switched to the off state. The amplifier can only be activated again when the temperature of the heat sink drops down to a permissible value. In order to clear the *OVL* LED, the output must be explicitly switched off using the switches *EN EXE / EXT EXE* [11] or *OUTPUT OFF/ON* [14] or by a corresponding level at the *EXT ENABLE* input [10], and then switched on again.
- [7.2] **FAN warning**  
If the fan does not rotate, a fault is present or the fan is blocked externally. The danger exists that the amplifier may be damaged as a result of excessively high temperatures. The amplifier is therefore switched off, the *FAN* warning LED lights up. The amplifier is switched on automatically as soon as the fan rotates again, and the *FAN* warning LED is deleted.
- [8] **Power switch with POWER LED**  
Used to switch the amplifier on and off. The *POWER* LED signals the switched-on state when lit.
- [9] **INPUT socket**  
The input signal is connected to this BNC socket. The input impedance and input coupling can be selected on the switch assembly. The maximum input voltage should not permanently exceed 12 V<sub>rms</sub>.
- [10] **EXT ENABLE socket**  
A signal with TTL level can be connected to this BNC socket in order to switch over the output of the amplifier between off and on state. The signal polarity is influenced by the switch *EN EXE / EXT EXE* [11] and linked to the position of the switch *OUTPUT OFF/ON* [14] (→ table below). The open input is interpreted as TTL High, a short-circuit as TTL Low. In this manner it is possible to implement remote switching using a cable and a simple switch.

	EXT ENABLE open or TTL-High		EXT ENABLE short-circuited or TTL-Low	
	OUTPUT OFF	OUTPUT ON	OUTPUT OFF	OUTPUT ON
EN EXE	off state	on state	off state	off state
EXT EXE	off state	off state	off state	on state



- [11] *EN EXE / EXT EXE* switch  
In conjunction with the logic level at the input *EXT ENABLE* [10], this switch influences the requirements in order to isolate the amplifier output using the switch *OUTPUT OFF/ON* [14] (→ table under *EXT ENABLE* [10]).
- [12] Output sockets  
The output signal is present on the outer laboratory safety sockets, the inner sockets are the connections of the sensor lines for four-wire mode. The specified polarity identifies the phase position with respect to the middle conductor of the BNC input socket *INPUT* [9], i.e. a positively increasing input signal between the core and screen of the BNC socket generates a positively increasing output signal between the positive and negative output sockets.
- [13] *SENSING LED*  
Lights up if four-wire mode is switched on (→ *SENSING ON* [1.8] on the switch assembly).
- [14] *Output OFF/ON* switch  
This switch can be used to switch the amplifier output to the high-impedance off state. An externally applied voltage must not exceed the maximum range for the output voltage. The conditions for executing the output (on state) are set by the position of the *EN EXE / EXT EXE* switch [11] and by the logic level at the input *EXT ENABLE* [10] (→ Table under *EXT ENABLE* [10]).



### 3. Technical specification

**Note** | The specifications are valid following a switch-on period of at least 30 minutes, at constant conditions, and at a reference temperature of 23°C ±1°C.

#### 3.1 Amplifier data

Amplifier model	TOE 7610-10	TOE 7610-20	TOE 7610-40	TOE 7610-60
Output voltage	0 ... ± 10 V	0 ... ± 20 V	0 ... ± 40 V	0 ... ± 60 V
Output current	± 15 A	± 7.5 A	± 4 A	± 2.5 A
Current limit (SLOW mode only)				
CURR LIMIT POS (variable separately)	0 ... +15 A	0 ... +7.5 A	0 ... +4 A	0 ... +2.5 A
CURR LIMIT NEG (variable separately)	0 ... -15 A	0 ... -7.5 A	0 ... -4 A	0 ... -2.5 A
Power (permanently at I <sub>max</sub> )				
Source mode	150 W		160 W	150 W
Sink mode with POWER MANAGER ON*	150 W		160 W	150 W
Frequency range (power bandwidth -3 dB)				
DC input coupling				
SPEED SLOW			0 Hz ... 30 kHz	
SPEED FAST			0 Hz ... 100 kHz	
AC input coupling				
SPEED SLOW			2 Hz ... 30 kHz	
SPEED FAST			2 Hz ... 100 kHz	
Gain				
INPUT V RANGE ±5 V				
VAR GAIN OFF	x 2	x 4	x 8	x 12
VAR GAIN ON	x 2 ±10 %	x 4 ±10 %	x 8 ±10 %	x 12 ±10 %
INPUT V RANGE ±10 V				
VAR GAIN OFF	x 1	x 2	x 4	x 6
VAR GAIN ON	x 1 ±10 %	x 2 ±10 %	x 4 ±10 %	x 6 ±10 %
DC input impedance				
DC input coupling				
INPUT IMPEDANCE 50 Ω			50 Ω	
INPUT IMPEDANCE 100 kΩ			100 kΩ	
AC input coupling				
INPUT IMPEDANCE 50 Ω			50 Ω	
INPUT IMPEDANCE 100 kΩ			∞	
Max. input voltage (permanently)			12 V <sub>rms</sub>	
Slew rate (FAST mode only)	ca. 6 V/μs	ca. 10 V/μs	ca. 16 V/μs	ca. 25 V/μs
Noise				
up to 1 kHz		< 0.1 mV <sub>rms</sub>		< 0.2 mV <sub>rms</sub>
up to 10 MHz		< 1 mV <sub>rms</sub>		< 2 mV <sub>rms</sub>
Total harmonic distortion				
SPEED SLOW				
up to 1 kHz	< 0.3 %	< 0.1 %	< 0.1 %	< 0.1 %
up to 7 kHz	< 0.8 %	< 0.4 %	< 0.3 %	< 0.3 %
up to 10 kHz	< 1.0 %	< 0.5 %	< 0.4 %	< 0.4 %
SPEED FAST				
up to 20 kHz	< 0.2 %	< 0.1 %	< 0.1 %	< 0.1 %
up to 40 kHz	< 0.3 %	< 0.2 %	< 0.2 %	< 0.2 %
up to 50 kHz	< 0.5 %	< 0.3 %	< 0.2 %	< 0.2 %

\* not available for TOE 7610-10

## 3.2 General data

<b>General</b>	Amplifier output	Floating; insulation $\pm 260 V_{DC}$ against ground	
	Mains voltage	230 V/115 V $\pm 10\%$ , 48 ... 65 Hz	
	Line fuse	230 V: T2AL; 115 V: T4AL; acc. to IEC 127-2/III, DIN 41662	
	Power consumption	Max. approx. 400 VA	
	Protective measures	Protection class I acc. to EN 61010-1	
	Operating temperature	0 ... 40°C	
	Storage temperature	-20 ... 70°C	
	Reference temperature	23°C $\pm 1^\circ\text{C}$	
	Cooling	Temperature-controlled fan	
	Dimensions (WxHxD)	216x132x429 mm; with feet 216x147x429 mm	
	19" system	System-compatible with $\frac{1}{2}$ 19", 3 HU	
	Weight	Approx. 9 kg	
	Housing	Aluminium	
<b>Ordering information</b>	Four-quadrant amplifier		
	DC ... 100 kHz	$\pm 10 V/\pm 15 A$	TOE 7610-10
	DC ... 100 kHz	$\pm 20 V/\pm 7.5 A$	TOE 7610-20
	DC ... 100 kHz	$\pm 40 V/\pm 4 A$	TOE 7610-40
	DC ... 100 kHz	$\pm 60 V/\pm 2.5 A$	TOE 7610-60
<b>Supplied accessories</b>	1 power supply cable		
	1 instruction manual		