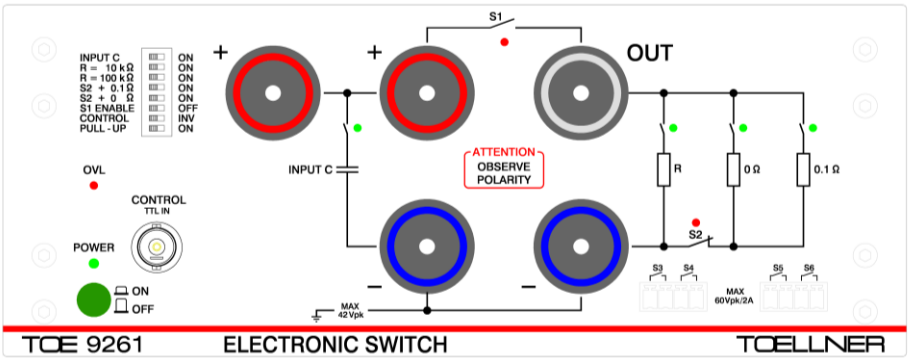
Instruction Manual

Electronic Switch

TOE 9261

9261E-Manual-Rev05.doc



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Subject to technical changes

Contents **Page**

Warning

This device has been constructed and inspected in conformity with DIN EN 61010-1, "Safety requirements for electrical equipment for measurement, control and laboratory use", and left the plant in perfect condition with respect to safety technology and meets Safety Class I. To maintain this condition and ensure hazard-free operation, the user must observe the instructions and warnings contained in this manual.

When operating electronic equipment certain parts in these devices are necessarily under dangerous voltage. Non-observance of the warnings may therefore result in severe bodily injury or damage to the equipment.

Only suitably qualified personnel should perform work on these devices or in their vicinity. Flawless and safe operation of these devices presumes correct transport, proper storage, assembly as well as careful operation and maintenance.

Qualified personnel according to this manual are persons who are familiar with the assembly, startup and operation of the devices and who possess the corresponding qualifications for their work activity.

1. Introduction

The electronic switches of the **TOE 9261** series are used for time-specific switching on and off of load and signal currents. These devices use an electronic, unidirectional power switch as well as four electronic bidirectional signal line switches. The power switch can be used either to switch a positive supply line or to switch the return line, e.g. for ground interruption tests. When using the switch in the positive supply line, a branch path parallel to the load can be additionally connected for specific discharging of buffered loads.

A digital input signal can be used to generate on and off durations of any length down to the microsecond range for both the power switch and the signal line switches.

Series **TOE 9261** switches are therefore ideal for use in test systems or any other applications where current paths from consumers or control devices need to be closed or interrupted for defined time intervals.

1.1 Features

1.1.1 General feature set

An essential feature of the series **TOE 9261** electronic switches is the electronic power switch, which is constructed of a longitudinal path and a branch path. Both paths can be used unidirectional, i.e. with a fixed, specified current direction.

In order to switch a positive supply line, the longitudinal path represents the actual switching path via which the energy flow takes place from a feeding source to the connected consumer.

The branch path in this case is arranged parallel to the consumer and can be optionally connected via a DIL switch. It serves as needed to selectively discharge a buffered consumer or a buffered load during the turn-off phase of the longitudinal path. It is possible to select either a direct parallel connection to the consumer or a parallel connection via a 0.1 Ω series resistor.

DIL switches are used to continually switch resistances of 10 kΩ or 100 kΩ to the output as high-impedance base loads, i.e. parallel to the consumer.

If the return line of the load is switched, the switch otherwise used as branch path carries the load current. Base load impedances parallel to the consumer are not available in this configuration.

The switching states of the power switch as well as the states of the selectable elements for the load circuit are displayed by LEDs.

Another feature of the series **TOE 9261** electronic switches are the four electronic bidirectional signal line switches, which can be operated selectively in any direction. These signal line switches are used to switch low currents such as occur on control or signal lines.

Control of the switching states of as well as the power and signal line switches is accomplished as desired using a front panel or rear BNC input. A DIL switch can be used to internally invert the control signal.

A further DIL switch can be used to connect a pull-up resistor to the BNC input, thus making possible control using an open collector or open drain switch.

The BNC inputs are compatible with TTL levels as well as CMOS 5 V and LVCMOS 3.3 V.

1.1.2 Overview of features

Basic functions

- Electronic power switch consisting of longitudinal and branch path, both paths unidirectional for specified current flow direction
- Branch path selectable inactive, active without series resistor or active with series resistor 0.1 Ω
- High-impedance loads of 10 kΩ or 100 kΩ can be continually applied
- Applicability of branch path for switching ground lines or return lines
- Capacitive buffering of input can be applied
- Four electronic bidirectional signal line switches
- BNC control inputs at front and rear
- Control signal can be internally inverted
- Pull-up resistor can be connected to the control inputs
- Control inputs compatible with TTL, CMOS 5 V, and LVCMOS 3.3 V
- Permissible switching frequency DC up to 100 kHz
- Protected against overcurrent / short-circuit, excessive temperature, excessive switching frequency

1.2 Model overview

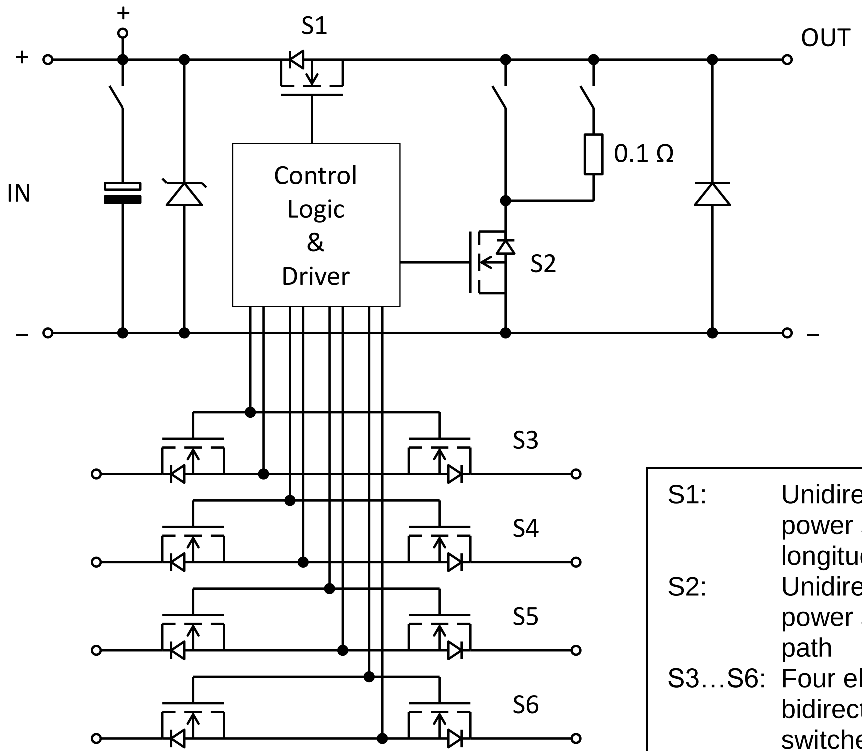
Series **TOE 9261** devices are available in models for various rated currents. The rated current of the power switch is indicated by a hyphenated number added to the basic part number.

The rated currents for the signal line switches as well as the rated voltages are shown in the following table.

Series **TOE 9261** electronic switches

Model	Power switch		Signal line switches	
	Current	**Voltage**	**Current**	**Voltage**
TOE 9261-50	0 - 50 A	0 - 60 V	0 - 2 A	0 - 60 V
TOE 9261-100	0 - 100 A	0 - 60 V	0 - 2 A	0 - 60 V

1.3 Schematic diagram for TOE 9261



S1: Unidirectional electronic power switch, longitudinal path
S2: Unidirectional electronic power switch, branch path
S3…S6: Four electronic bidirectional signal line switches

2. Operation

2.1 Startup

Warning

Safe operation of these devices presumes that they have been placed in service properly by qualified personnel in compliance with the warnings in this manual.

In particular the general installation and safety regulations (e.g. DIN/EN and VDE) must be observed. Non-observance may result in death, serious personal injury or major damage to equipment.

These devices meet Protection Class I (protective earth connection) according to DIN EN61010-1. Before powering up, be sure that the mains voltage agrees with the permissible operating voltage of the device (→ 4.1 Technical data TOE 9261 and the rating plate). Except in areas with special protection measures, the mains plug must only be inserted in a socket having a PE contact. The protection effect must never be defeated through use of an extension cable not having a protective earth. The mains plug must be inserted in the socket before the device is turned on and the measuring and control circuits connected. Any interruption in the protective earth inside or outside the unit or removal of the protective earth connection may result in a hazardous condition for the device. No intentional interruption of the protective earth connection is permitted. Observe local regulations for earthing.

Ensure that only fuses of the specified type and specified current are used as replacements (→ 4.1 Technical data TOE 9261 and the rating plate). The use of repaired fuses or short circuiting the fuse holder is not permitted.

If it is apparent that non-hazardous operation is no longer possible, the devices must be taken out of service and secured against unintended operation.

2.1.1 Installation and ventilation

There are no problems associated with installation of these devices.

The devices include a thermostatically controlled fan which brings in air from the sides and below and blows it out to the rear. Provide sufficient ventilation distance so that the rear fan can work effectively. Otherwise it can happen that under high load conditions the unit will heat up to a point where it is automatically shut off (→ 2.6.4 Excessive temperature protection).

Series **TOE 9261** devices are designed so that they can be used either as tabletop units or in 19" rack systems. Appropriate adapters for 19" rack use are available as an option.

2.1.2 Preparations

ON
OFF

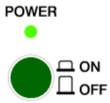
After connecting the mains supply and pressing the POWER switch the device is ready. This is indicated by the green power LED above the mains switch.

2.2 Description of the controls

At the end of the manual you will find the various operating and display elements for the series **TOE 9261** numbered with front panel and rear views. In the following the individual operating elements are explained in detail.

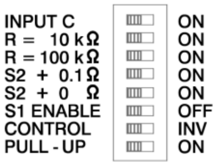
2.2.1 Front panel controls

[1]



Mains switch for turning the power to the device on and off. When the unit is ON the green *POWER* LED will be illuminated.

[2]



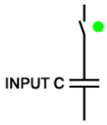
8x DIL switch. Assignments from top to bottom (Nos. 1 to 8):

1. **INPUT C:** Apply input buffer capacitor to input socket pair *Plus – Minus*. Indication by green LED.
2. **R = 10 kΩ:** Apply high-impedance base load 10 kΩ parallel to output socket pair *OUT – Minus*. Indication by green LED.
3. **R = 100 kΩ:** Apply high-impedance base load 100 kΩ parallel to output socket pair *OUT – Minus*. Indication by green LED.
4. **S2 + 0.1 Ω:** Apply branch path switch *S2* with 0.1 Ω series resistor. Indication by green LED (→ 2.4.9 Use of the branch path).
5. **S2 + 0 Ω:** Apply branch path switch *S2* without series resistor: Internal resistance ≈ 0 Ω. Indication by green LED (→ 2.4.9 Use of the branch path).
6. **S1 ENABLE:** Activation / deactivation of switch *S1* in order to carry out ground interruptions using switch *S2* (→ 2.4.5 Connection of the consumer for switching a ground line)
7. **CONTROL:** Inversion of the control signal present at front panel or rear CONTROL input
8. **PULL-UP:** Apply pull-up resistor of approx. 22 kΩ to the front panel or rear CONTROL input

[3]

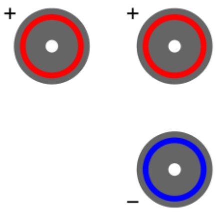
Front panel BNC input *CONTROL* for controlling the switching state both for the power switch and the signal line switches (→ 2.4.7 Control of switching paths and operation of the consumer, → 2.5.2 Control).

[4]



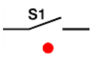
Selectable input buffer capacitor. This appears parallel to the input socket pair *Plus – Minus*. The selection is indicated by the green LED next to the switch symbol.

[5]



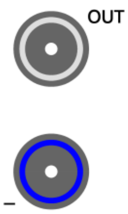
Input sockets *Plus – Minus* of power switch. The input voltage should preferably be connected to the right-hand *Plus* socket and to the *Minus* socket. The left-hand *Plus* socket is used to connect the input voltage for carrying out ground interruptions.
An appropriate voltage source should be used to provide the input voltage. The polarity and magnitude of the voltage must be observed; not more than the rated voltage of the **TOE 9261** may be applied.

[6]

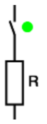


Longitudinal path switch *S1* of the power switch. Across this the connection between the sockets *Plus* and *OUT* is applied. When *S1* is conductive the red LED below the switch symbol will be illuminated.

[7]



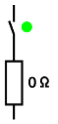
Output socket *OUT* and right-hand *Minus* socket of the power switch. In order to switch the positive supply line of a consumer, this must be connected to *OUT* and to the right-hand *Minus* socket. If, on the other hand, the return line of the consumer is to be switched, the consumer must be connected with the positive pole to the right-hand *Plus* socket [5] and the negative pole to *OUT*.
The voltage connected to *OUT* (in the case of a buffered and possibly preloaded consumer) must not be more positive than the voltage at the *Plus* sockets or more negative than the voltage at the *Minus* sockets.

[8] 

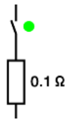
Selectable base load 10 kΩ or 100 kΩ. This appears parallel to the output socket pair *OUT – Minus*. The selection is indicated by the green LED next to the switch symbol.

[9] 

Branch path switch *S2* of the power switch. This is used when switching the positive supply line of a consumer to jumper the consumer during the switch-off time (switch *S1* of longitudinal path non-conductive) in order e.g. to discharge a buffer stage present in the consumer. To this end, *S2* is connected via the corresponding switching function of the 8-fold DIL switch [2]. It is possible to select use of *S2* without or with the inserted 0.1 Ω series resistor (→ 2.4.9 Use of the branch path). The 0.1 Ω series resistor is used e.g. to implement the test signal in accordance with LV 124, version 2009, test E-10, test case 3.
If, on the other hand, the return line of a consumer is switched, *S2* carries the load current (→ 2.4.5 Connection of the consumer for switching a ground line).
When *S2* is conductive the red LED above the switch symbol will be illuminated.

[10] 

0 Ω series resistor for the branch path. When the branch path is selected in conjunction with this resistor, the green LED next to the switch symbol will be illuminated.

[11] 

0.1 Ω series resistor for the branch path. When the branch path is selected in conjunction with this resistor, the green LED next to the switch symbol will be illuminated.

[12] 

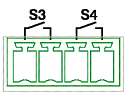
Red *OVL* LED (Overload). Comes on when a shutdown has occurred due to one of the following fault conditions:

- Max. switching frequency of 100 kHz on the control input has been exceeded
- Overcurrent
- Excessive temperature

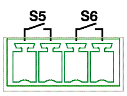
A reset following a switching frequency fault is done by reducing the frequency at the control input, or in case of overcurrent or excessive temperature by turning the unit off and on using the mains switch. The reason for the overcurrent must be identified and the cause removed. In case of excessive temperature the unit can be restarted only after a sufficient cooling down time (→ 2.6 Protection).

[13] 

Polarity notice for the power switch. Voltages must be connected only with the correct polarity. This means for the *OUT* socket that the connected voltage (in the case of a buffered and possibly preloaded consumer) must not be more positive than the voltage at the *Plus* sockets or more negative than the voltage at the *Minus* sockets.

[14] 

Terminal block for signal line switches *S3* and *S4*. These can be used with suitable terminal block plugs (→ 4.1 Technical data TOE 9261, Connections, Signal line switches).
The control and signal lines to be switched are routed through the signal line switches indicated by the switch symbols *S3* and *S4*. The connections for unused signal line switches are left open.
The signal line switches are closed and opened synchronous with each other and synchronous with closing and opening of the longitudinal path *S1* of the power switch.

[15] 

The terminal block for the signal line switches *S5* and *S6*. The same explanations apply as for *S3* and *S4* [14].

2.2.2 Rear panel controls

[20] Identifier	The identifier shows the current version and the installed options for the unit.
[21] Protective earth	This screw connects the housing to the protective earth. **<u>Attention</u>: This connection must never be removed!**
[22] 	Rear-side BNC input *CONTROL* for controlling the switching state both for the power switch and the signal line switches (→ 2.4.7 Control of switching paths and operation of the consumer→ 2.5.2 Control).
[23] Rating plate	The rating plate contains the following information: Company name, device series, serial number, supply voltage with mains fuse and current draw.
[24] Mains plug with mains fuse	This 3-pole standardized plug is used with the mains power cord. Integrated into the plug is the chamber for the device fuse with an additional compartment for a spare fuse.

2.3 General operation features

Operation of the **TOE 9261** for setting the desired switch and control configuration is carried out using an 8-fold DIL switch on the front panel. The states of the selectable elements for the load circuit as well as the switching states of the power switch are displayed by LEDs.

Switching time settings are made on the clock source used (e.g. function generator), which may if desired be connected to the front or rear BNC input *CONTROL* on the **TOE 9261**.

2.4 Power switch operation

2.4.1 Connection of the input voltage source

To operate the power switch a DC voltage source (power supply, battery) is connected to the input socket pair *Plus* – *Minus*. If the right-hand *Plus* socket is not used by the load for carrying out ground interruptions (→ 2.4.5 Connection of the consumer for switching a ground line), the input voltage should be connected to this socket and to the *Minus* socket; otherwise to the left-hand *Plus* socket and the *Minus* socket.

The applied voltage must be not greater than the rated voltage for the **TOE 9261**. Overlaying with AC voltage is permissible as long as the input buffer capacitor is not applied and the maximum momentary value of the total applied voltage does not exceed the rated voltage of the **TOE 9261** and the minimum momentary value is not negative. Setting a current limit at the source with a value appropriate to the consumer or providing protection against overcurrent is required.

Warning

> It is imperative that the source be connected to the input sockets *Plus* – *Minus* with the **correct polarity**! Otherwise damage to the Electronic Switch may result.
>
> A current limiter or overcurrent fuse for the feed source is absolutely required.

2.4.2 Insertion of artificial networks

Depending on the requirement an impedance network, for example when operating or testing motor vehicle components, an artificial network (AN) can be placed between the voltage source and the input sockets or the output sockets and the consumer. In case of an artificial network (AN) between voltage source and input sockets the input buffer capacitor should not be applied, because otherwise the artificial network (AN) will be without effect.

2.4.3 Application of the internal input buffer capacitor

In all cases in which the internal input buffer capacitor can be used (DC input voltage without overlaying with AC voltage, no artificial network between voltage source und input sockets), this capacitor should be connected using the DIL switch $\boxed{\text{INPUT C / ON}}$. This results in an improvement of the switching times, especially a shorter rise time. For indication the green LED next to the related switch symbol is illuminated.

2.4.4 Connection of the consumer for switching the positive supply line

The consumer to be operated is connected to the *OUT* socket and the right-hand *Minus* socket. Since the *S1* switch carries the load current, the DIL switch [S1 ENABLE] must be in the left position.

Warning In the described switch configuration, the negative return line must always be connected from the consumer to the voltage source via the minus sockets of the **TOE 9261**. These minus sockets must never be bypassed, because otherwise some protection mechanisms of the Electronic Switch are without effect, and damage to the Electronic Switch may result.

2.4.5 Connection of the consumer for switching a ground line (minus)

The consumer to be operated is connected with the positive pole to the right-hand *Plus* socket and the negative pole to the *OUT* socket. The latter is the switched ground point. Since the load current is connected via the *S2* switch in this configuration, this must be activated using the DIL switch [S2 + 0 Ω] in position [ON]. The green LED next to the related switch symbol is illuminated.

Warning When switching a ground line (minus), the [S2 + 0.1 Ω] setting must never be selected, otherwise the internal 0.1 Ω resistor would be overloaded during the flow of current.

The *S1* switch parallel to the load can be deactivated by setting the DIL switch [S1 ENABLE] to [OFF]. Otherwise the load would be discharged via *S1* during the interruption. With deactivation of the *S1* switch also the above-mentioned improper load current flow via the 0.1 Ω resistor is automatically locked.

Warning In the described switch configuration, the positive supply line from the voltage source to the consumer must always be connected via the *Plus* sockets of the **TOE 9261**. These plus sockets must never be bypassed, because otherwise some protection mechanisms of the Electronic Switch are without effect, and damage to the Electronic Switch may result.

2.4.6 Connection of the control signal

A digital switching signal for controlling the power switch can be connected as desired to the front panel or rear BNC *CONTROL* socket. A suitable clock source must be provided. This signal should be compatible with one of the logic standards CMOS 5 V, LVCMOS 3.3 V or TTL. Suitable devices include function generators in square wave or pulse mode as well as arbitrary waveform generators (AWG) with digital waveforms. Voltages above 5 V as well as negative voltages or voltages which extend into the negative range may not be used. Control signals with a frequency up to 100 kHz can be used. An overload switch-off is carried out above this frequency.

2.4.7 Control of switching paths and operation of the consumer

The digital switching signal is used to control the state of the paths *S1* and *S2*. A conductive path is thereby indicated by the red LED at the switch symbol *S1* or *S2* (→ 2.4.8 Display of the switching states). If the DIL switch [CONTROL / INV] is in the left position (i.e. no inversion), *S1* is conductive and *S2* is non-conductive during a High level of the switching signal.

If however the DIL switch [CONTROL / INV] is set to [INV], *S1* is non-conductive and *S2* is conductive during a High level of the switching signal.

This results in the following possible operating conditions:

Configuration of TOE 9261 and consumer	DIL switch CONTROL / INV	CONTROL signal	Consumer status
Switching of positive supply line	--	Low	Disconnected (OFF)
	--	High	**Supplied (ON)**
	INV	Low	**Supplied (ON)**
	INV	High	Disconnected (OFF)
Switching of return line (ground)	--	Low	**Supplied (ON)**
	--	High	Disconnected (OFF)
	INV	Low	Disconnected (OFF)
	INV	High	**Supplied (ON)**

The appropriate setting of the CONTROL / INV DIL switch can therefore be selected depending on the desired configuration (switching of positive supply line or of return line) and the desired function of the control signal (High level should lead to supply of consumer or to disconnection from the supply).

In the disconnected status of the consumer, a buffer stage present in the consumer and possibly still charged is discharged if one of the two following cases exists:

- **TOE 9261** and consumer were connected in the configuration for switching the positive supply line, and one of the two DIL switches S2 + 0.1 Ω and S2 + 0 Ω is set to ON (→ 2.4.9 Use of the branch path).
- **TOE 9261** and consumer were connected in the configuration for switching the return line (ground), and the DIL switch S1 ENABLE was not set to OFF.

Note

If the *CONTROL* input is not connected or controlled but left in a high-impedance state, this is evaluated as Low level. If in this case either the DIL switch CONTROL / INV is set to INV or the DIL switch PULL-UP / ON to ON, the internally evaluated level changes to High, resulting in switching path *S1* becoming conductive and switching path *S2* non-conductive. In the configuration for switching the positive supply line, the consumer is then permanently connected to the supplying voltage source.
In the configuration for switching the return line (ground), on the other hand, the consumer is permanently connected to the supplying voltage source if – with the *CONTROL* input left in a high-impedance state – the named DIL switches are either both in the left-hand or both in the right-hand positions.

2.4.8 Display of the switching states

A conductive path *S1* or *S2* is indicated by the red LED at the related switch symbol. To ensure always the perceptibility of the display, in case of high frequencies or short High or Low pulses of the switching signal at the *CONTROL* input, not the actual fast changing switching states are displayed, but it is calculated a slowed down signal for the display LEDs. The switching paths themselves, however, are controlled by the timing of the switching signal.

2.4.9 Use of the branch path

In the configuration for switching the positive supply line, *S2* represents the load parallel branch path. The switching state of the branch path *S2* is always complementary to the state of the longitudinal path *S1*. This means the consumer can be jumpered with *S2*, while *S1* is open (not conducting). This allows for example a buffer stage in the consumer to be discharged.

To achieve the fastest possible discharging without a series resistor, DIL switch S2 + 0 Ω must be set to ON. For indication the green LED next to the related switch symbol is illuminated.

If, instead of this, DIL switch S2 + 0.1 Ω is set to ON, discharging is via a series resistor of 0.1 Ω, e.g. for realization of the test signal according to LV 124, version 2009, test E-10, test case 3. Again, the green LED next to the related switch symbol is illuminated for indication. This setting is only possible if not already the discharging without series resistor was chosen.

If no discharging is to carried out using *S2*, make sure that the two named DIL switches are in the left-hand positions.

It must always be noted with buffered consumers that the rise and fall times are lengthened. High buffer capacities with low series resistance values (ESR) can also result in triggering of the overcurrent fuse.

Warning

Feedback from the (buffered) load side to the *OUT* output of the power switch must have the indicated polarity and not exceed the rated voltage of the **TOE 9261**! A voltage inversion into the negative is only permissible after blocking *S1* by means of inductance-dependent, further flowing load current.

Non-observance of this may result in damage to the Electronic Switch.

In the configuration for switching the return line (ground), the switching path *S1* is parallel to the consumer. If e.g. a test setup in accordance with LV 124, version 2013, test E-13 is used and this test is applied to a ground line, discharging of the load is not intended during the ground interruption. The DIL switch S1 ENABLE must then be set to OFF.

If in other applications the consumer is to be jumpered during the ground interruption, the switching path *S1* can be used for this by setting the DIL switch S1 ENABLE to the left-hand position. Direct load jumpering is then available during the ground interruption; the looping-in of a series resistor into the jumpering path is not possible in this configuration.

Note that with buffered consumers the rise and fall times are lengthened. High buffer capacities with low series resistance values (ESR) can also result in triggering of the overcurrent fuse.

Warning

Feedback from the (buffered) load side to the *OUT* output of the power switch must have the indicated polarity and not exceed the rated voltage of the **TOE 9261**, i.e. the voltage connected to *OUT* must not be more positive than the voltage at the *Plus* sockets or more negative than the voltage at the *Minus* sockets! A voltage exceedance into the positive is only permissible after blocking *S2* by means of inductance-dependent, further flowing load current.

Non-observance of this may result in damage to the Electronic Switch.

2.4.10 High-impedance base load

DIL switches R = 10 kΩ / ON and R = 100 kΩ / ON can be used to permanently switch corresponding resistances to the output socket pair *OUT – Minus*, i.e. independent of the switching state of paths *S1* and *S2.* These serve in the configuration for switching the positive supply line as high-impedance base loads. For indication the green LED next to the related switch symbol is illuminated. It is also possible to select both resistors at the same time, i.e. as a parallel circuit.

No connectable base loads are available in the configuration for switching the return line (ground).

2.4.11 PWM operation of a consumer

Consumers which are suitable for use with pulse width modulation (PWM) can be used with the **TOE 9261**. The frequency of the digital switching signal which is sent to one of the *CONTROL* inputs corresponds to the frequency of the PWM signal; the pulse/pause ratio of the switching signal results in the duty cycle of the PWM.

The current which is drawn by the consumer during the turn-on phase of the PWM is allowed to have values up to the rated current of the **TOE 9261**. If the current draw is higher, the overcurrent protection on the **TOE 9261** may be triggered during the turn-on phase of the PWM.

The **TOE 9261** is in principle suitable for switching frequencies up to 100 kHz. Depending on the voltage and current requirement of the consumer as well as the cable inductance from the feeding source to the input socket pair *Plus – Minus*, this maximum frequency may however not be reached, but rather the **TOE 9261** will shut off at even a significantly lower frequency due to overload, which is indicated by the *OVL* LED.

The reason for this overload in this case will be the inductive energy from the incoming line, which continues to flow into the **TOE 9261** for each turn-off event in the longitudinal path and which is converted as a product factor of the switching frequency into power loss.

The following measures must be taken to increase the achievable switching frequency:

- Minimize the cable length to the input socket pair *Plus – Minus*
- Parallel, closely adjacent routing of both cable conductors
- Use of a feed source with high output buffer capacity
- Applying the input buffer capacitor of the **TOE 9261** by setting the DIL switch INPUT C / ON to ON. The built-in capacitor is thermally protected against too high ripple current load which may be caused by high consumer currents at high PWM switching frequencies.

Warning Consumers which are not expressly approved for PWM operation may not be turned on and off at high switching frequencies, since otherwise buffer stages in the consumer, e.g. electrolytic capacitors, can overheat and be damaged by excessive ripple current loads!

2.5 Operation of the signal line switches

2.5.1 Connection

To switch signal lines, they are routed through the bidirectional switches *S3 – S6*. They are connected using the correspondingly labeled front panel connectors. These can be used with suitable terminal block plugs (→ 4.1 Technical data TOE 9261, Connections, Signal line switches)

S3 – S6 provide four bidirectional signal line switches, for example to be able to turn on or interrupt a multi-pole signal connection simultaneously. The terminals for unneeded signal line switches are left unconnected.

The direction of current flow through the signal line switches *S3 – S6* can be selected as desired and independent of each other.

The upper limit of the applied signal levels is limited to the rated voltage of the **TOE 9261**. The electrical isolation between the signal line switches and to the *CONTROL* input is for up to 42 V_{peak}.

2.5.2 Control

Closing and opening the signal line switches *S3 – S6* takes place synchronous with each other as well as synchronous with closing and opening of the longitudinal path *S1* of the power switch. The signal line switches are controlled further even if the longitudinal path *S1* is disabled per DIL switch S1 ENABLE in the OFF position.

The functions and possible uses of the *CONTROL* input are the same as described for the power switch (→ 2.4.7 Control of switching paths and operation of the consumer) except for the information which explicitly refers to operation of a load via the paths *S1* and *S2*.

2.6 Protection

Series **TOE 9261** devices use various protective devices which serve to prevent serious damage to the units.

Warning

Make absolutely sure that the supplying voltage source is connected to the input sockets *Plus – Minus* with the proper polarity!

Feedback from the (buffered) load side to the *OUT* output of the power switch must have the indicated polarity and not exceed the rated voltage of the **TOE 9261**, i.e. the voltage connected to *OUT* must not be more positive than the voltage at the *Plus* sockets or more negative than the voltage at the *Minus* sockets! A voltage exceedance into the negative or positive direction is only permissible after blocking *S1* or *S2* by means of inductance-dependent, further flowing load current

Non-observance of these instructions may result in damage to the Electronic Switch.

2.6.1 Overcurrent and short-circuit protection of the switching paths

The overcurrent and short-circuit protection of the switching paths is designed to guard the **TOE 9261** against overload from excessive currents. It extends through the longitudinal and branch paths of the power switch as well as through the signal line switches.

When the overcurrent and short-circuit protection is triggered, the internal driver stages are permanently turned off, i.e. the switching paths are no longer driven.

This fault status is indicated by the *OVL* LED.

A reset is accomplished by turning the unit off and on using the mains switch. The cause of the overcurrent or short-circuit must be identified and eliminated.

2.6.2 Input overcurrent protection

The input overcurrent protection guards the power switch against excessively high periodic supply of power which results from the inductance on the input cable at the moment the longitudinal path is turned off.

When the input overcurrent protection is triggered, the internal driver stages are permanently turned off, i.e. the switching paths are no longer driven.

A fault condition is indicated by the *OVL* LED.

Reset by turning the unit off and on using the mains switch.

The following measures can be taken to prevent too high periodic supply of inductive energy and thereby an undesired triggering of the input overcurrent protection:

- Minimize the cable length to the input sockets *Plus – Minus*
- Parallel, closely adjacent routing of both cable conductors
- Use of a feed source with high output buffer capacity
- Apply the built-in input buffer capacitor

2.6.3 Protection against exceeding of the maximum switching frequency

To protect against excessive switching losses and against excessive driver output, the maximum switching frequency is limited.

Applying a higher frequency at the *CONTROL* input results in shutting off of the internal driver stages, i.e. the switching paths are no longer driven.

This fault condition is indicated by the *OVL* LED.

The fault condition remains as long as the non-permitted switching frequency is present. If the frequency is first reduced significantly below the permissible limit (taking into account a hysteresis), the device automatically clears the fault condition and the switching paths are again driven. The permissible switching frequency range is then again available.

2.6.4 Excessive temperature protection

The excessive temperature protection responds to excessive component temperatures in the unit. This protection is provided in two stages. For continuous operation at high voltage, high current and high switching frequency, the fan speed is first increased.

If the component temperatures continue to rise, the internal driver stages are shut off, i.e. the switching paths are no longer driven.

This fault condition is indicated by the *OVL* LED.

After an appropriate cool-down time the unit can be reset by turning it off and on using the mains switch.

3. Configuring for 19" rack mount

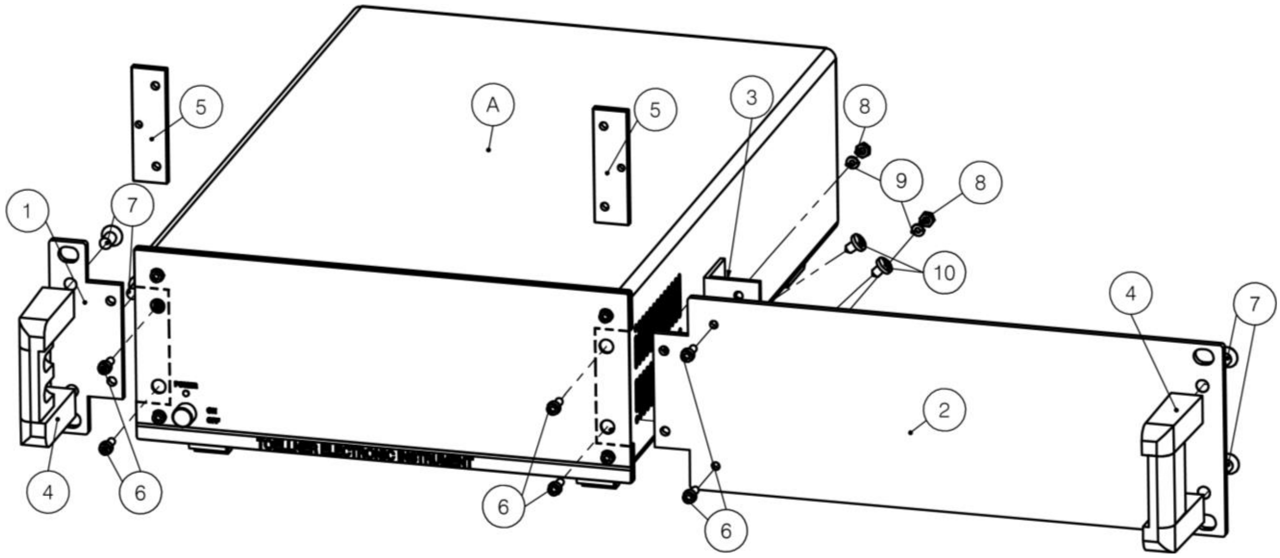
3.1 19" adapter set (2 HU) for 1x TOE 9261 (option)

The series **TOE 9261** Electronic Switches are 19" rack-capable tabletop devices. By using the optional **TOE 9521** one **TOE 9261** can be easily converted for 19" 2 HU rack mount.

The optional 19" adapter set **TOE 9521** includes a 19" adapter piece with handle and a 19" compensation panel with handle as well as the necessary installation materials.

Reconfiguring from 1x TOE 9261 to 19" rack mount

1. Use the included TX 20 screwdriver to remove the feet from the Electronic Switch. First remove the rubber inserts on the front feet.
2. Use the included Allen wrench to remove the two inner screws (6) on the left and right side of the front panel of the Electronic Switch. Pull the two fill strips (5) from the side.
3. For the left or right side attach a handle (4) with countersunk screws (7) to the 19” adapter piece (1). Insert this unit in replacement for the fill strip and screw it on to the front panel using the hexagon socket screws (6).
4. For the other side attach the adapter bracket (3) to the 19” compensation panel (2) using the hexagon socket screws (6), the spring washers (9), and the nuts (8). Also attach the handle (4) with countersunk screws (7) to the 19” compensation panel (2). Insert this pre-assembled unit in replacement for the fill strip and screw it on to the front panel using the hexagon socket screws (6).
5. Use the thread-forming screws (10) to attach the adapter bracket (3) of the above-mentioned unit additionally to the side holes provided as shown in the diagram.



1: 19" adapter piece 2 HU
2: 19" compensation panel 2 HU
3: Adapter bracket
4: Handle
5: Fill strip
6: Hexagon socket screw M3 x 8
7: Countersunk screw M5 x 12
8: Nut M3
9: Spring washer for M3
10: Thread-forming screw 3.9 x 6.5

Installing in the 19" rack

The 19" unit must be located on the device side on a slide rail. This slide rail as well as the fasteners needed for attaching the unit in the 19" rack are not included in the scope of delivery for this option.

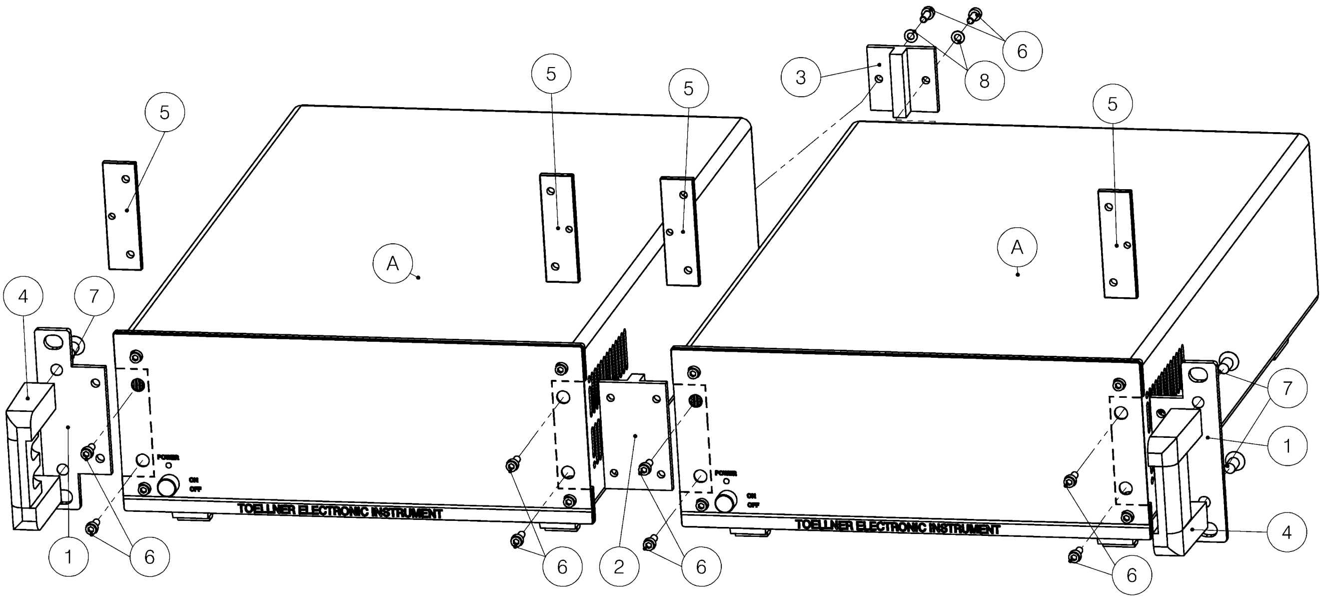
3.2 19" adapter set (2 HU) for two Toellner Instruments ½ 19" (option)

The series **TOE 9261** Electronic Switches are 19" rack-compatible tabletop devices. By using the optional **TOE 9522** two Toellner Instruments ½ 19" (2 HU) of equal length can be easily converted for 19" 2 HU rack mount.

The optional 19" adapter set **TOE 9522** includes two 19" adapter pieces with handle, a front connecting profile, and a rear connecting profile as well as the necessary installation materials (see diagrams on the following page).

Reconfiguring from two Toellner Instruments ½ 19" to 19" rack mount

1. Use the included TX 20 screwdriver to remove the feet from the two devices. First remove the rubber inserts on the front feet.
2. Use the included Allen wrench to remove the two inner screws (6) on the left and right side of the front panel of each device. Pull the four fill strips (5) from the side.
3. For the outer faces of the devices attach a handle (4) to a 19" adapter piece (1) each using the countersunk screws (7). Insert these units in replacement for the fill strips and screw them on to the front panels using the hexagon socket screws (6).
4. In the center insert the front connecting profile (2) in replacement for the fill strips and screw it on to the front panels using the hexagon socket screws (6).
5. Use the Allen wrench to remove the inner mounting screw (6) of each housing at the rear of the two devices.
6. Fasten the two devices together using the rear connecting profile (3), the provided screws M3x10 (6), and the contact disks (8).



1: 19" adapter piece 2 HU
2: Front connecting profile
3: Rear connecting profile
4: Handle
5: Fill strip
6: hexagon socket screw M3 x 8
7: Countersunk screw M5 x 12
8: Contact disk for M3

Installing in the 19" rack

The 19" unit must be located on both sides on slide rails. These slide rails as well as the fasteners needed for attaching the unit in the 19" rack are not included in the scope of delivery for this option.

4. Technical data

Note The technical data are based on a warm-up time of at least 30 minutes under constant conditions and a reference temperature of 23°C ±1°C.

4.1 Technical data TOE 9261

Model	TOE 9261-50	TOE 9261-100
Input voltage		
Power switch	**0 - 60 V**	**0 - 60 V**
Signal line switches	**0 - 60 V**	**0 - 60 V**
Load current		
Power switch, longitudinal path		
Continuous current	**0 - 50 A**	**0 - 100 A**
Peak current	**300 A**	**300 A**
Power switch, branch path		
Continuous current	**0 - 50 A**	**0 - 100 A**
Peak current	**300 A**	**300 A**
Signal line switches	**0 - 2 A**	**0 - 2 A**
Voltage drop		
Power switch, longitudinal path	**< 0.2 V** at 50 A	**< 0.3 V** at 100 A
Power switch, branch path	**< 0.2 V** at 50 A	**< 0.3 V** at 100 A
Signal line switches	**< 0.4 V** at 2 A	
Switching frequency f_{MAX}	**100 kHz**	
Power switch switching times		
Rise time t_r with reference resistor 1 Ω		
With connected input buffer capacitor	**< 0.5 µs**	
Without buffer capacitor, input cable 0.50 m twisted	**< 1.2 µs**	
Without buffer capacitor, input cable 1.20 m twisted	**< 2.0 µs**	
Rise time t_r with reference resistor 100 Ω		
With or without input buffer capacitor, input cable ≤ 1.2 m twisted	**< 0.5 µs**	
Fall time t_f with reference resistor 1 Ω or 100 Ω		
With or without input buffer capacitor, input cable ≤ 1.2 m twisted	**< 0.5 µs**	
PWM operation of power switch		
Operating duration		
With load current ≤ 50 A	**No limitation**	**No limitation**
With load current > 50 A … ≤ 100 A (automatic switch-off at overload)	--	**Typ. 5 min**
Switching frequency		
With duty cycle 50 %, input cable 0.50 m twisted		
With input voltage 14 V	**DC up to 100 kHz**	
With input voltage 40 V	**DC up to typ. 20 kHz**	
	(→ 2.4.11 PWM operation of a consumer)	
Switching times for signal line switches		
Rise time t_r		
With 1 Ω load, V_{IN} = 2 V	**< 2.5 µs**	
With 1 kΩ load	**< 0.1 µs**	
Fall time t_f		
With 1 Ω load, V_{IN} = 2 V	**< 1.5 µs**	
With 1 kΩ load	**< 6.5 µs**	

(Technical data, cont.)

Attenuations for signal line switches	
Blocking attenuation With 100 Ω system impedance	 **8 kHz / -40 dB**
Bandwidth With 100 Ω system impedance	 **38 MHz / -3 dB**
Protection functions	
Overcurrent or short-circuit of the switching paths Monitoring Reaction Reset	 Continuous current and peak current Switching off of switching paths, display OVL Switching off and on again using mains switch
Input current Monitoring Reaction Reset	 Averaging of the inductive energy supplied per switching operation from the supply line to the device input Switching off of switching paths, display OVL Switching off and on again using mains switch *Note: The incoming energy can be minimized by a short cable, arranged for low-inductance.*
Max. switching frequency exceeded Monitoring Reaction Reset	 Frequency present at the control input Switching off of switching paths, display OVL Reduction in the switching frequency below the permissible value with consideration of a hysteresis of typically 5 kHz
Excessive temperature Monitoring Reaction Reset	 Temperatures of the power components Stage 1: Increase in fan speed Stage 2: Switching off of switching paths, display OVL Switching off and on again using mains switch following appropriate cooling period
Power switch is <u>not</u> reverse polarity protected! Reverse polarity voltage applied to the input or output can damage the unit from excess current or thermal overload.	
Connections	
Mains voltage	Appliance plug. Voltage range see “General”
Control input Rated voltage range and impedance Trigger threshold Protective circuit / overvoltage range Impedance outside the rated voltage range	1x BNC, unearthed, at front 1x BNC, unearthed, at rear -0.5 … 5.5 V / 1 MΩ < 2 V (compatible with TTL, CMOS 5V and LVCMOS 3.3V) Self-resetting fuse / protection up to ± 20 V > 1 kΩ
Power switch	
Input sockets Plus – Minus	High-current socket pair 6 mm red / blue, with touch protection
Output socket OUT	High-current socket 6 mm gray, with touch protection
Second pair of sockets Plus – Minus	High-current socket pair 6 mm red / blue, with touch protection
Signal line switches	
Inputs/outputs	Front side connector for connecting screw terminal blocks with 3.81 mm spacing Matching screw terminal blocks are e.g.: Phoenix MC 1.5 / 4-ST-3.81 = Article No. 1803594 Würth Elektronik plug-in cable system WR-TBL Series 361 = Article No. 691361300004
Electrical isolation	Between power switch, signal line switches, control input and PE, max. 42 V_{peak} each

(Technical data, cont.)

General	
Mains voltage	Wide-range input 90…264 V AC, 47-63 Hz, I_{max} = 0.4 A, rear appliance plug with fuse T1AL according to IEC 127-2/III, DIN 41662
Power consumption, mains side	Max. 35 VA
Protection	Protection Class I according to DIN EN 61140
	Degree of protection IP20 according to IEC 60529
	Overvoltage category II according to IEC 60664-1
	Pollution degree 2 according to IEC 60664-1
Operating temperature	0 - 40°C
Storage temperature	−20 - 70°C
Reference temperature	23°C ±1°C
Cooling	2-stage thermostatically controlled fan
Overall dimensions (W x H x D)	224 mm x 103 mm x 348 mm
Rack mount dimensions (W x H x D)	224 mm x 88 mm x 325 mm
19" system	Compatible with ½ 19", 2 HU
Weight	Approx. 4 kg
Housing	Aluminum/steel

4.2 General data

Ordering options

0-50 A, 0-60 V.....TOE 9261-50
0-100 A, 0-60 V.....TOE 9261-100

Included accessories

1 mains cable
2 terminal blocks for signal line switches
1 Instruction Manual

Optional accessories

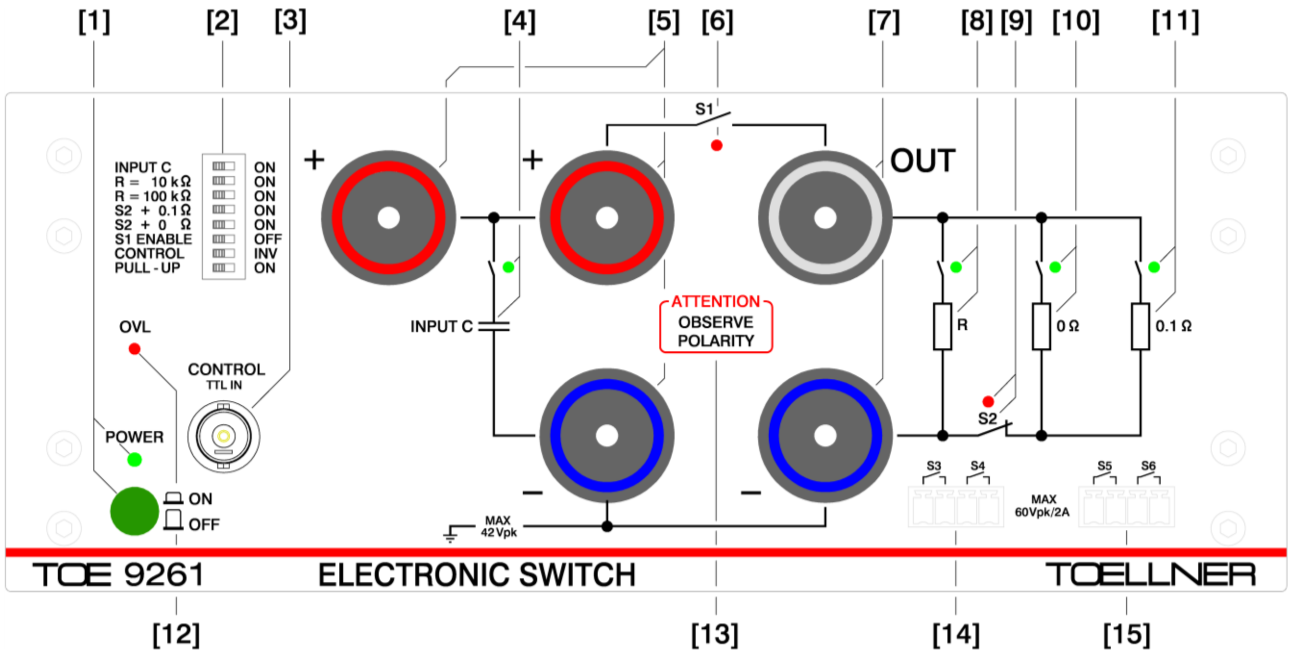
0.50 m connection cable with 1 safety socket, red .... TOE 9260/22
0.50 m connection cable with 1 safety socket, blue... TOE 9260/23
1.20 m connection cable with 1 safety socket, red .... TOE 9260/24
1.20 m connection cable with 1 safety socket, blue... TOE 9260/25
19" adapter set 2 HU (asymmetrical) for 1x TOE 9261 .... TOE 9521
19" adapter set 2 HU (parallel connector) for 2 Toellner Instruments ½ 19" .... TOE 9522

4.3 Specification of the high-current connectors

The built-in high-current connectors of the TOE 9261 are the following components:
TOE 9261-50.........Safety flush-mounting plug, type ID/S6AR-N-B4S, manufacturer Multi-Contact
TOE 9261-100 ......Safety flush-mounting plug, type ID/S6AR-N-S, manufacturer Multi-Contact

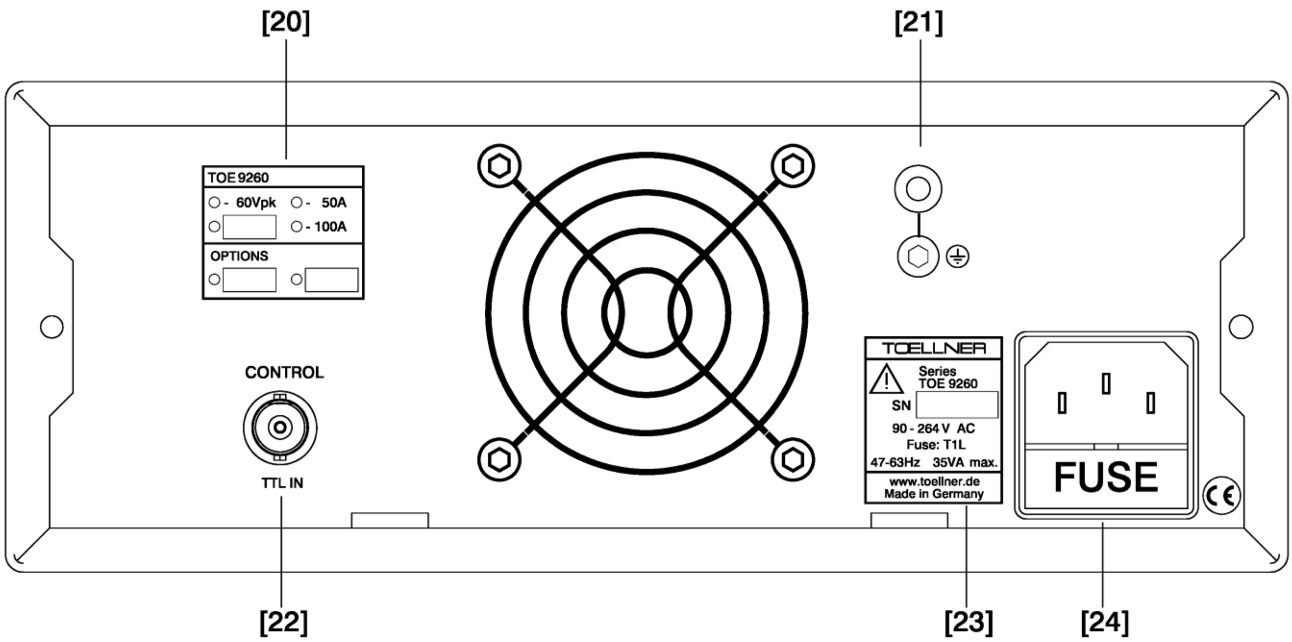
Suitable counter piece for crimping assembly on cables is the following:
TOE 9261-50 and TOE 9261-100....... Safety socket, type KBT6AR-N/16-S, manufacturer Multi-Contact.
This counter piece can only be attached to a cable by crimping assembly using special tooling, soldering is impossible.

5. Views



Front panel view of the **TOE 9261**

[1] Mains switch with green *POWER* LED
[2] 8x DIL switch
[3] Front BNC control input
[4] Selectable input buffer capacitor with green indication LED
[5] Power switch input
[6] Power switch, longitudinal path incl. red indication LED
[7] Power switch output
[8] Selectable base load 10 kΩ or 100 kΩ with green indication LED
[9] Power switch, branch path incl. red indication LED
[10] 0 Ω series resistor for branch path with green indication LED
[11] 0.1 Ω series resistor for branch path with green indication LED
[12] Red *OVL* LED (overload)
[13] Polarity reminder
[14] Connections for signal line switches S3 and S4
[15] Connections for signal line switches S5 and S6



Rear view of the **TOE 9261**

[20] Identifier
[21] Protective earth
Do not unscrew!
[22] Rear BNC control input
[23] Rating plate
[24] Mains panel plug, with fuse