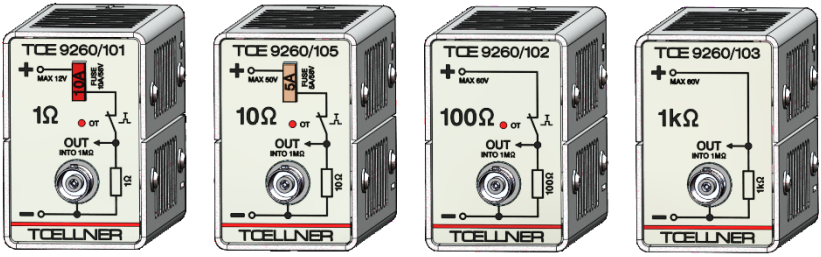
Instruction Manual

Reference Resistors 1 Ω, 10 Ω, 100 Ω, 1 kΩ for the TOE 9260 Electronic Switch series

TOE 9260/100

9260E-Opt100-Manual-Rev05



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TCE 9060/101
1Ω
TCE 9060/105
10Ω
TCE 9060/102
100Ω
TCE 9060/103
1kΩ

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1. Product description

The **Reference Resistors 1 Ω, 10 Ω, 100 Ω, and 1 kΩ** for the **TOE 9260** electronic switch series are intended for performing reference measurements according to the following automotive test standards:

- LV 124 – 2013 and later for 12 V electrical systems
- VDA 320 – 2014 and later for 48 V electrical systems

In detail, the following Reference Resistors are provided.

The **TOE 9260/101** is a low-inductive power resistor **1 Ω** / 144 W for short-term operation at a voltage of up to 12 V.

The **TOE 9260/105** is a low-inductive power resistor **10 Ω** / 250 W for short-term operation at a voltage of up to 50 V.

The **TOE 9260/102** is a low-inductive power resistor **100 Ω /** 36 W for operation at a voltage of up to 60 V.

The **TOE 9260/103** is a low-inductive resistor **1 kΩ** / 3.6 W for continuous operation at a voltage of up to 60 V.

1.1 Features

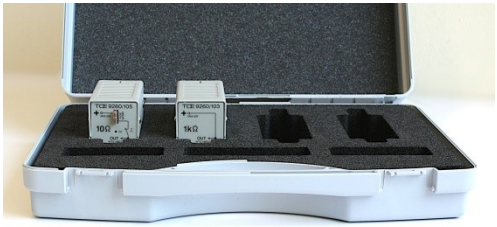
- Low inductance
- 5% resistance tolerance
- Thermal overload protection for the 1 Ω, 10 Ω, and 100 Ω resistors
- Lead fuse for the 1 Ω and 10 Ω resistors
- Dedicated input plugs matching the output sockets of the electronic switches of the TOE 9260 series
- BNC output 50 Ω; high impedance measurement equipment intended

1.2 Available resistor kits

The Reference Resistors are offered for the specific application as resistor kits with several resistors (→ 4.2 General data).

TOE 9260/100: Reference Resistor Kit
1 Ω, **100 Ω**, **1 kΩ** for LV 124 tests

TOE 9260/110: Reference Resistor Kit
1 Ω, **10 Ω**, **100 Ω**, **1 kΩ** for LV 124- und VDA 320 tests



TOE 9260/120: Reference Resistor Kit
10 Ω und **1 kΩ** for VDA 320 tests

2. Safety

2.1 Danger symbols

This manual contains warnings and notes which have to be observed to prevent personal injury or damage to equipment. These warnings and notes are highlighted by symbols as follows:

The CAUTION symbol means that minor physical injury or damage to equipment can result if the warnings are not followed. In all cases where this symbol appears, the instruction manual must be followed.

The NOTE symbol means an important or additional piece of information that shall be emphasized.

2.2 Startup

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 personal injury or damage to equipment.

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

Ensure that only fuses of the specified type and current are used for replacement (→ 4.2 General data). The use of repaired fuses or short-circuiting the fuse holder is not permitted.

3. Operation

3.1 Installation, ventilation, and environment

The Reference Resistors are plugged directly into the output sockets of an electronic switch **TOE 9260** or **TOE 9261**.

All Reference Resistors use vents in the housing for heat dissipation. Provide sufficient ventilation distance so that the vents can work effectively.

High load conditions on the **1 Ω, 10 Ω,** and **100 Ω** resistors can cause these resistors to heat up considerably. At too high operation temperatures an automatic shut-off is triggered (→ 3.4.1 Excessive temperature protection). Good air circulation prolongs the available operating time before the automatic shut-off.

For the **Reference Resistor 1 kΩ**, no ventilation is needed because of the small power dissipation.

The Reference Resistors should not be operated in a dusty environment or exposed to an aggressive atmosphere. Also operation in a wet environment is not permitted. For the allowed pollution degree, degree of protection, and operating temperature range refer to the technical data section of this manual (→ 4. Technical specifications).

The Reference Resistors 1 Ω, 10 Ω, and 100 Ω **become hot during operation.** Under normal operating conditions, the housing reaches surface temperatures of up to 60 °C.
In the event of a malfunction of the built-in thermal switch to protect against excessive component temperatures, however, the surface temperature can rise to over 100 °C.
Therefore, when handling the resistors in or after operation, **first carefully check** whether the housing temperature permits safe contact with the resistors.

The **Reference Resistors 1 Ω, 10 Ω,** and **100 Ω** may only be operated on electronic switches of the TOE 9260 series and only with voltages up to the values specified on the front panels of the Reference Resistors. No higher voltage may be applied. Otherwise overloads or the risk of electric shocks can occur.

3.2 Description of the functional elements

The individual functional elements of the Reference Resistors are explained in detail below. At the end of the manual you will find front and rear views of the Reference Resistors with the corresponding designation numbers (→ 5. Device views).

3.2.1 Front panel functional elements

[1] **Lead fuse** for protection against too high current when the rated voltage is exceeded. Only for **1 Ω** and **10 Ω** Reference Resistor.

TOE 9260/101, 1 Ω: MINI blade fuse 10 A / 58 V (Replacement: → 4.2 General data)

TOE 9260/105, 10 Ω: MINI blade fuse 5 A / 58 V (Replacement: → 4.2 General data)

The 58 V rating of the fuses is necessary for the breaking capability at excessive operating voltages.
To retain protection of the power resistor, fuses with higher rated current values or lower voltage ratings **must not** be inserted.

[2]  **BNC output** for measuring the voltage across the Reference Resistor during switching operation. This socket is internally decoupled from the Reference Resistor via a 50 Ω series resistance.

[3] 

OT LED: This LED is illuminated when the overtemperature protection was triggered and a voltage of at least 3 V remains applied to the **Reference Resistor 1 Ω** or **100 Ω**; or 5 V in case of the **Reference Resistor 10 Ω**. After a sufficient cooling down time the overtemperature protection resets automatically, and this LED switches off again.

3.2.2 Rear panel functional elements

[4] [5] 

Input plugs for connection of the Reference Resistor to the output sockets of the **TOE 9260** or **TOE 9261** electronic switch. The polarity is indicated by plus and minus signs in the housing of the unit.

Swapping the polarity is not critical for the Reference Resistors themselves, but should be avoided with respect to the polarity of the measuring signal.

[6] Rating plate — The rating plate contains the following data: Company name, device series, serial number.

3.3 Application of the Reference Resistors

The **Reference Resistors 1 Ω, 10 Ω, 100 Ω,** and **1 kΩ** are intended for performing reference measurements at the power output of the **TOE 9260** or **TOE 9261** electronic switch. Underlying standards are LV 124, edition 2013 or later, or VDA 320, edition 2014 or later.

In detail, the reference measurements for the following tests can be carried out. The required reference resistors are offered in corresponding kits:

Standard	Test	Reference Resistors	Kit
LV 124	E-10, Short interruptions	1 Ω, 100 Ω	TOE 9260/100
LV 124	E-13, Pin interruption	1 Ω, 1 kΩ	
VDA 320	E48-09, Short interruptions	10 Ω, 1 kΩ	TOE 9260/120

LV 124 + VDA 320, all four resistors as listed above:	TOE 9260/110

3.3.1 Setup of the components

To prepare a reference measurement, the input of the **TOE 9260** or **TOE 9261** must be connected to a DC voltage source as specified in the test description. This voltage can be provided by a power supply or by a specific control unit which provides a control signal to be interrupted. The polarity and current flow direction of the power switch of the electronic switch **TOE 9260** or **TOE 9261** must be observed.

No voltage may be applied above the value that is specified on the front panel of the currently operated Reference Resistor. Otherwise overloads or the risk of electric shocks can occur (→ 3.1 Installation, ventilation, and environment).

The lines from the DC voltage source to the input sockets of the electronic switch should be kept as short as possible and should be laid twisted to achieve a low line inductance. In addition, in a test of a *supply* line interruption of the device under test (not to be used when a control line shall be interrupted), the input buffer capacitor of the electronic switch should be activated.

The **Reference Resistor 1 Ω, 10 Ω, 100 Ω,** or **1 kΩ** is plugged directly into the output sockets of the **TOE 9260** or **TOE 9261** electronic switch. A suitable pulse waveform must be applied to the control input of the **TOE 9260** or **TOE 9261**.

For evaluation of the rise and fall times of the switching operations, the BNC output of the Reference Resistor must be connected to an oscilloscope:

For reference measurements in a 12 V system, which is the common application of the **Reference Resistors 1 Ω, 100 Ω,** or **1 kΩ**, the connection shall be established via a 50 Ω BNC cable to a high impedance oscilloscope input (usually 1 MΩ).

For reference measurements in a 48 V system, in which usually the **Reference Resistors 10 Ω** or **1 kΩ** are applied, the connection should be established via a passive oscilloscope probe with a 10:1 divider ratio and 10 MΩ input impedance. The probe should be connected to the BNC output of the Reference Resistor by use of a BNC adaptor which is usually an accessory part of the probe.

A low-impedance termination of the measuring signal, e.g. by a 50 Ω terminating resistor at the BNC cable, **must not** be applied. Also, the input channel of the oscilloscope **must not** be configured to a low impedance value. Otherwise, damage may occur due to excessive power loss in the termination resistor or in the input stage of the oscilloscope.
Moreover, in case of the Reference Resistor values of 10 Ω or higher the measured signal level would be severely affected by a low impedance termination.

3.3.2 Carrying out the reference measurement

Before carrying out the measurement, the resulting power loss in the respective Reference Resistor must be considered. To protect the resistors against overload, the **Reference Resistors 1 Ω, 10 Ω,** and **100 Ω** each have an internal reversible thermal circuit breaker. When operating with continuous DC voltage, the following operating times are possible until the thermal circuit breaker is triggered:

The **Reference Resistor 1 Ω** can be operated at 12 V for approx. 20 s. Subsequently, a cooling down time of approx. 3.5 min is necessary.

The **Reference Resistor 10 Ω** can be operated at 48 V for approx. 10 s. Subsequently, a cooling down time of approx. 6 min is necessary.

The **Reference Resistor 100 Ω** can be operated at 60 V for approx. 120 s. Subsequently, a cooling down time of approx. 90 s is necessary.

The **Reference Resistor 1 kΩ** has no protective measure, because the power dissipation is negligible at operation up to the rated voltage of 60 V.

These times are rough guidance values only, because the reachable operation time depends both on the initial temperature of the Reference Resistor and the ambient temperature.

Furthermore, the occurring power dissipation in the Reference Resistor can be significantly reduced by supplying a switching signal with a low duty cycle to the electronic switch **TOE 9260** or **TOE 9261** for the measurements.

3.3.3 Behavior of the Reference Resistors in case of overload

When the thermal circuit breaker of the **Reference Resistor 1 Ω, 10 Ω,** or **100 Ω** was triggered and a voltage of at least 3 V remains applied to the Reference Resistor (5 V in case of the **Reference Resistor 10 Ω**), the *OT LED* of the Reference Resistor is illuminated. After a sufficient cooling down time the circuit breaker resets automatically, and the *OT LED* switches off again.

The 10 A lead fuse of the **Reference Resistor 1 Ω** or the 5 A lead fuse of the **Reference Resistor 10 Ω** is triggered only in case of too high current by applying an excessive overvoltage to the unit. Under such operating conditions, the thermal circuit breaker inside the unit would no longer trip fast enough to avoid damage to the power resistor. For suitable replacement fuses see (→ 4.2 General data).

The 10 A rated current value of the fuse in the **Reference Resistor 1 Ω** is the suitable value for short-term operation at up to at least 12 A, which is the resulting current when the unit is operated at its rated voltage.

To retain protection of the power resistors, the fuses may only be replaced by fuses of the correct current values and voltage ratings, which are specified in this manual (→ 4.2 General data) and on the front panels of the **Reference Resistor 1 Ω** or **Reference Resistor 10 Ω**.

The 58 V rating of the fuses is required for the breaking capability at excessive operating voltages. Fuses of lower voltage ratings **must not** be used.

3.4 Protection devices

3.4.1 Excessive temperature protection

The **Reference Resistors 1 Ω, 10 Ω,** and **100 Ω** are protected against excessive temperatures by a reversible thermal circuit breaker. When this protection device is triggered, the current through the Reference Resistor is reduced to a small residual value. After a sufficient cooling down time, the current flow through the Reference Resistor is automatically switched on again.

The **Reference Resistor 1 kΩ** does not need a thermal protection because of its small power dissipation.

When the thermal circuit breaker was triggered and a test voltage of at least 3 V remains applied to the Reference Resistor (5 V in case of the **Reference Resistor 10 Ω**), the *OT LED* (OT = over temperature) of the Reference Resistor is illuminated. It indicates that the current flow through the Reference Resistor is interrupted. A measurement with the Reference Resistor is not meaningfully possible in this state.

3.4.2 Overvoltage and overcurrent protection

The **Reference Resistors 1 Ω** and **10 Ω** are protected against too high currents by a lead fuse (→ 4. Technical specifications). Such high currents are caused by operation at overvoltage above the rated voltage value.

A triggered fuse may only be replaced by a fuse of the same type as indicated on the front panel of the respective Reference Resistor (→ 3.2.1 Front panel functional elements).

The **Reference Resistors 100 Ω** and **1 kΩ** have no lead fuse because operation at up to 60 V is permissible.

4. Technical specifications

The technical specifications are based on constant conditions and a reference temperature of 23 °C ±1 °C.

4.1 Reference Resistor technical specifications

Reference Resistor	TOE 9260 /101	TOE 9260 /105	TOE 9260 /102	TOE 9260 /103
Characteristics				
Resistance value	1 Ω	10 Ω	100 Ω	1 kΩ
Tolerance	± 5%	± 5%	± 5%	± 5%
Rated voltage	12 V	50 V	60 V	60 V
Rated power	144 W	250 W	36 W	3.6 W
Operating time at rated DC voltage	approx. 20 s	approx. 10 s	approx. 120 s	not limited
Cooling-off time	approx. 3.5 min	approx. 6 min	approx. 1.5 min	--
Protective measures				
Thermal circuit breaker	●	●	●	--
Lead fuse	10 A / 58 V MINI blade fuse	5 A / 58 V MINI blade fuse	--	--
Connections				
Input connector	Dedicated plugs matching the output connectors of the TOE 9260 or TOE 9261			
Measurement output	BNC output 50 Ω; high impedance measurement equipment intended			
General				
Degree of protection	IP20 (IEC 60529)			
Pollution degree	2 (IEC 60664-1)			
Operating temperature	0 °C – 40 °C			
Storage temperature	−20 °C – 70 °C			
Reference temperature	23 °C ± 1 °C			
Cooling	Vents			
Dimensions (W x H x D)	48 mm x 64 mm x 129 mm			
Weight	approx. 300 g			
Housing	Aluminum			

4.2 General data

Ordering options

Reference Resistor Kit 1 Ω, 100 Ω, 1 kΩ
for LV 124 tests ..... TOE 9260/100
Reference Resistor Kit 1 Ω, 10 Ω,
100 Ω, 1 kΩ for LV 124 + VDA 320 tests ..... TOE 9260/110
Reference Resistor Kit 10 Ω and 1 kΩ
for VDA 320 tests ..... TOE 9260/120

Reference Resistor 1 Ω
as replacement part ..... TOE 9260/101
Reference Resistor 100 Ω
as replacement part ..... TOE 9260/102
Reference Resistor 1 kΩ
as replacement part ..... TOE 9260/103
Reference Resistor 10 Ω
as replacement part ..... TOE 9260/105

Included accessories

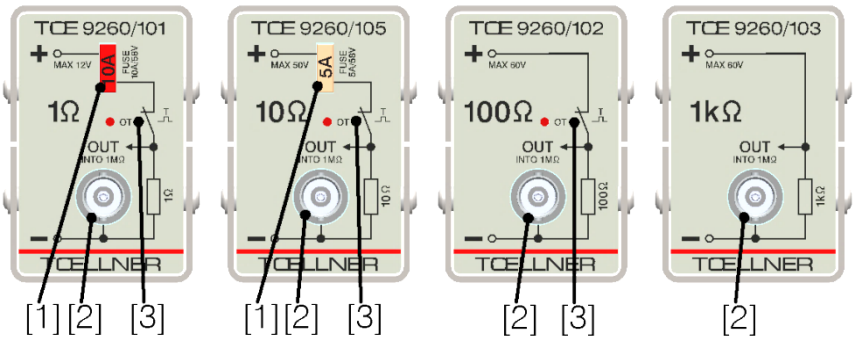
Instruction Manual
Spare fuse each for a Reference Resistor 1 Ω or 10 Ω
Fuse extraction tool
Storage case

Replacement fuses

MINI blade fuse 10 A / 58 V; e.g. Littelfuse, „MINI® Blade Fuse Rated 58 V“, 10 A
MINI blade fuse 5 A / 58 V; e.g. Littelfuse, „MINI® Blade Fuse Rated 58 V“, 5 A

5. Device views

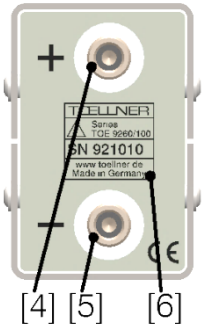
5.1 Front view of the Reference Resistors



[1] Lead fuse
[2] BNC output
[3] OT LED (OT = over temperature)

5.2 Rear view of the Reference Resistors

Rear view of all four Reference Resistors:



[4], [5] Input plugs
[6] Rating plate with serial number