

# Earth-Fault Compensation Controller EFC20 / EFC20i



**TRENCH**

## Application

In high impedance grounded power distribution networks the neutral point of the network is connected to earth by means of an inductor which is adjusted continuously or stepwise. If the resonance circuit formed by the adjustable inductive coil and the earth capacitance of the network is tuned to or close to resonance, the fault current is greatly reduced in case of a line-to-earth fault (earth fault). In most cases the arc caused by the fault current is extinguished without there being the need to switch off the faulty part of the network.

As the Arc Suppression Coil (ASC) and the earth capacitance form a resonance circuit, the neutral-to-ground voltage of the network depends on the value of the inductance of the ASC and reaches a maximum when the ASC is tuned to resonance. This dependence of the neutral-to-ground voltage is utilised by the EFC20 and EFC20i Earth-Fault Compensation Controller for automatic tuning of on load adjustable ASCs.

## Control Algorithm

### Minimal Coil Movement

During a tuning operation the ASC is adjusted by a small amount. Using the known coil-position as well as the neutral-to-ground voltage measured before and after the adjustment operation, the controller computes the detuning value  $v$ , the asymmetry value  $k$  and the damping value  $d$ , which determine the resonance curve of the neutral-to-ground voltage. Taking into consideration the desired, software-adjustable under- or overcompensation, the controller calculates the necessary position and directly adjusts the ASC to the calculated value.

### Determining the Resonance Peak by going beyond it

This method may be used if the asymmetry of the network is small, which results in very low neutral-to-ground voltages. In this case, network reactions may cause fluctuations of the neutral-to-ground voltage. Therefore it is not possible to compute reliably the parameters of the network by means of a small detuning of the ASC. So the controller adjusts the ASC over a wider range, which must include the resonance

peak. It stores the measured values and calculates out of these an average resonance curve. Taking into consideration the desired under- or overcompensation, it computes the necessary position and adjusts the ASC to that value.

### EFC20i

The EFC20i calculates the resonance curve by injecting a current into the zero-phase sequence system of the network and measuring the vectors of both the neutral-to-ground voltage and the injected current. Therefore detuning of the ASC is no longer necessary for the calculation procedure. Where a network is essentially symmetrical and the neutral-to-ground voltage extremely low, and no reliable control signal is readily available, it is possible to increase the neutral-to-ground voltage by using the permanent current injection in a way that changes of the network configuration ensuring a reliable signal for the controller (inverse operation mode). In case of an outage of the current injection, a further enhancement in reliability is ensured by changing to a redundancy control mode whereby the resonance curve is determined via a slight adjustment of the ASC.

## Conception - EFC20 / EFC20i

### Hardware

- microprocessor based controller 19"-rack mounted (3U)
- easy operation by means of a graphic LCD display and **scroll wheel**
- extended operation via PC by means of a **terminal program**
- LED indication of digital outputs

- central display of arc suppression coil alarms via LEDs
- serial interfaces
- **analogue output module**  
0 ... 20 mA outputs for external indication of coil position and neutral-to-ground voltage
- EFC20: prepared for **easy upgrade** to the Earth-Fault Compensation Controller EFC20i (see page 2)

### Hardware Options

- housing for wall-mounting
- cover strips for panel installation
- alternative power supply
- EFC20: **additional plug-in module** for digital inputs and outputs



fig. 1 Earth-Fault Compensation Controller EFC20i with 19"-rack mounted Current Injection Device ECI

## Operating

- **easy operating** by means of an integrated display and a new input method via scroll wheel
- **clear menu guide** with „help“ - text
- **automatic, adaptive menu** according to activated software options
- easy adaptation to individual net conditions via **preset and transcribable parameter adjustments**
- terminal program **EFCTerm** for Windows for parameter setting and on-site operation via PC as well as for remote control by means of modem



fig. 2 operating panel

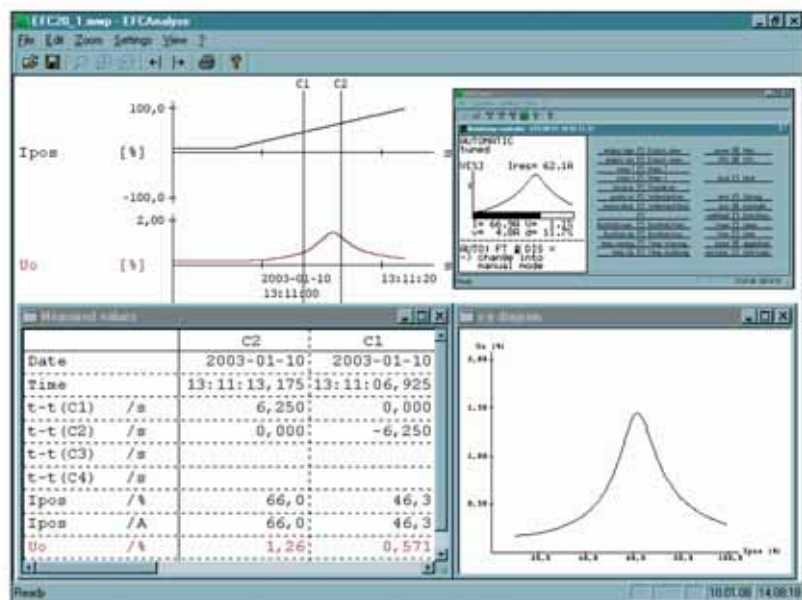


fig. 3 EFCTerm

## Software

- **easy parameter setting**, since pre-adjusted factory assignments can be transcribed from user
- **extra flexibility** through software controlled inputs and outputs, free assignment of digital outputs to different state functions as well as free assignment of digital inputs to different control functions
- indication of operating status via **text messages**
- **counting of various events** (e.g. transient earth fault) and controller conditions for statistical evaluations
- **remote parameter changes** by means of a PC connected via modem to the serial interface
- **3 menu access levels** for users
- **software-update** via serial interface

## Software Options

- **several controllers** within the same network (reliable control without mutual influences), no remote connection necessary
- adjusting the ASC to a **predefined value** when the ASC is switched off
- automatic **resistor control**
- **control of an additional fixed coil** (automatic switching on/off of the fixed coil)
- **control back to ideal compensation** ( $v=0$ ) if an earth fault occurs
- **SCADA** (SPABus or IEC60870-5-103)
- automatic switching of a damping resistor during search operation if **U exceeds  $U_{max}$**

## Technical Data – EFC20 / EFC20i

	EFC20	EFC20i
<b>hardware</b>		
operating 16 line display, 21 symbols per line scroll wheel	x	x
serial interface for SCADA, PC or modem 2 pieces RS 232, 9 pin optional 1x front and 1x rear or 2x rear	x	x
analogue voltage inputs 3 mV ... 110 V AC 50 Hz rated burden < 0,5 VA	1(+2)*	3
analogue current inputs 0 ... 1 A AC 50 Hz	(2)*	2
analogue outputs for Vo, coil position 0 ... 20 mA DC, software programmable	2	2
coil position linear potentiometer 0 ... 200 ohms resp 0 ... 2000 ohms or 0 ... 20 mA DC input signal	1	1
digital inputs potential free contacts 24 ... 230 V AC/DC, tripping threshold software programmable	9 (+6)*	15
digital outputs potential free change over contacts, 230 V AC/DC, max 5 A continuous max contact current closing rating 1000 VA max contact interrupting rating 30 VA	3	3
digital outputs potential free make contacts, 230 V AC/DC, max 5 A continuous max contact current closing rating 1000 VA max contact interrupting rating 30 VA	(14)*	14
digital outputs potential free change over contacts, 230 V AC/DC, max 5 A continuous and potential free make contacts, 230 V AC/DC, max 5 A continuous max contact current closing rating 1000 VA max contact interrupting rating 30 VA	3	3
auxiliary voltage 100 ... 240 V AC/DC (other voltages on request)	x	x

\*(...) Option

	EFC20	EFC20i	Option (EFC20 / EFC20i)
<b>software</b>			
automatic earth fault compensation control of stepless adjustable plunger core coils	x		
automatic earth fault compensation control of stepless adjustable plunger core coils by means of the current injection into the zero-sequence system		x	
terminal program EFCTerm for Windows	x	x	
automatic, adaptive menu	x	x	
measurement memory	x	x	
3 menu access levels for users	x	x	
software-update via serial interface	x	x	
several controllers within the same network system			x
predefined coil position			x
automatic resistor control			x
fixed coil control			x
control back to ideal compensation ( $v=0$ ) at earth fault condition			x
SCADA			x
automatic switching if U exceeds $U_{max}$			x

<b>mechanical data</b>	
dimensions	width 483.0 mm height 132.5 mm depth 320.0 mm
weight	ca. 5 kg
temperature	operating 0°C ... +40°C storage -25°C ... +55°C transport -25°C ... +70°C
humidity	class G acc to DIN 40040
protection class	IP20

## ECI Current Injection Device

The Current Injection Device ECI is used to produce differential measurement values by means of the current injection into the zero-phase sequence system. This approach is used by both the Earth-Fault Compensation Controller EFC20i (see page 2) and the Earth-Fault Detection Device EFD20 (see brochure E667). Where a network is essentially symmetrical and the neutral-to-ground voltage extremely low, and no

reliable control signal is readily available, it is possible to increase the neutral-to-ground voltage by using the permanent current injection in a way that changes of the network configuration ensuring a reliable signal for the controller (inverse operating mode implemented in the EFC20i control algorithm). The current injection into the zero-phase sequence system is usually done via a power auxiliary

winding of the Arc Suppression Coil.

The Current Injection Device ECI essentially consists of a transformer, capacitors for current limiting, relays, control- and signal contacts.

**The following designs are available:** indoor design, outdoor design, mounting plate for installation in an existing cubicle, 19"-rack mounting.

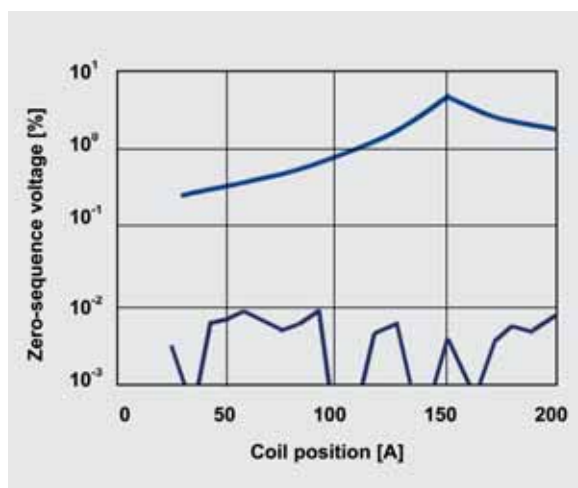


fig. 4 Increase of the zero-sequence voltage by means of continuous current injection



fig. 5 ECI in conventional design (indoor design, outdoor design and design on mounting plate available)



fig. 6 ECI 19"-rack mounted

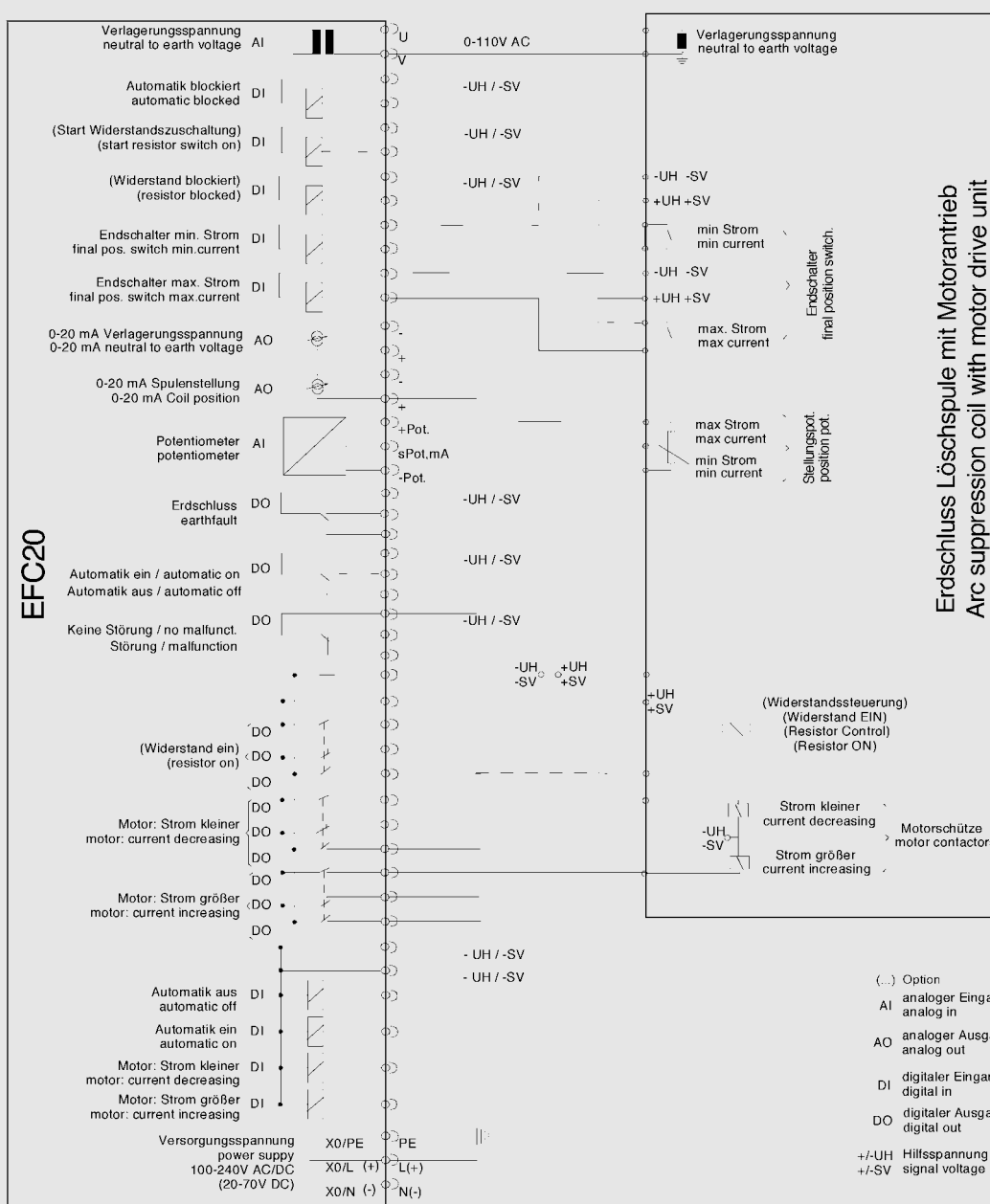
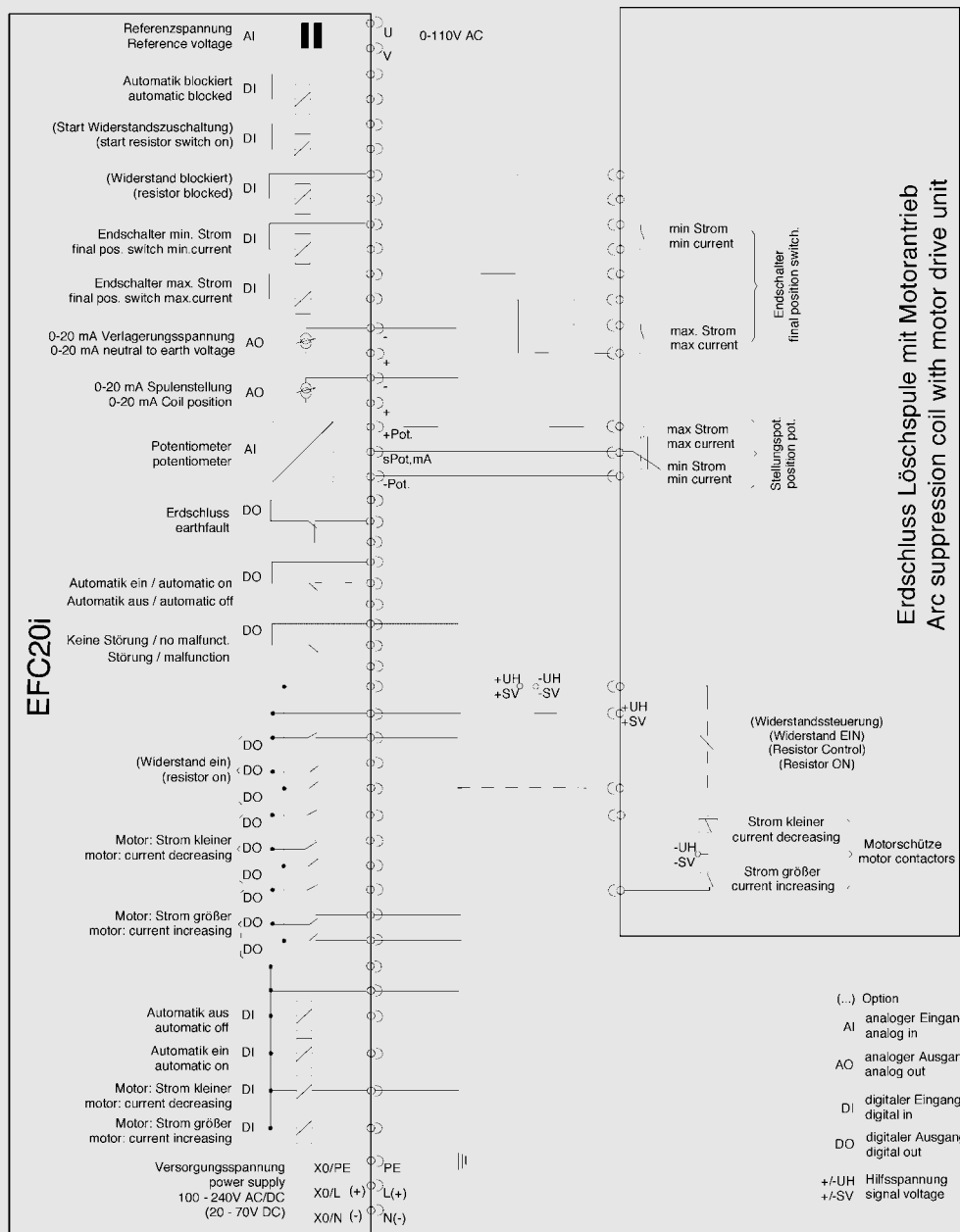


fig. 7 EFC20 wiring diagram - standard



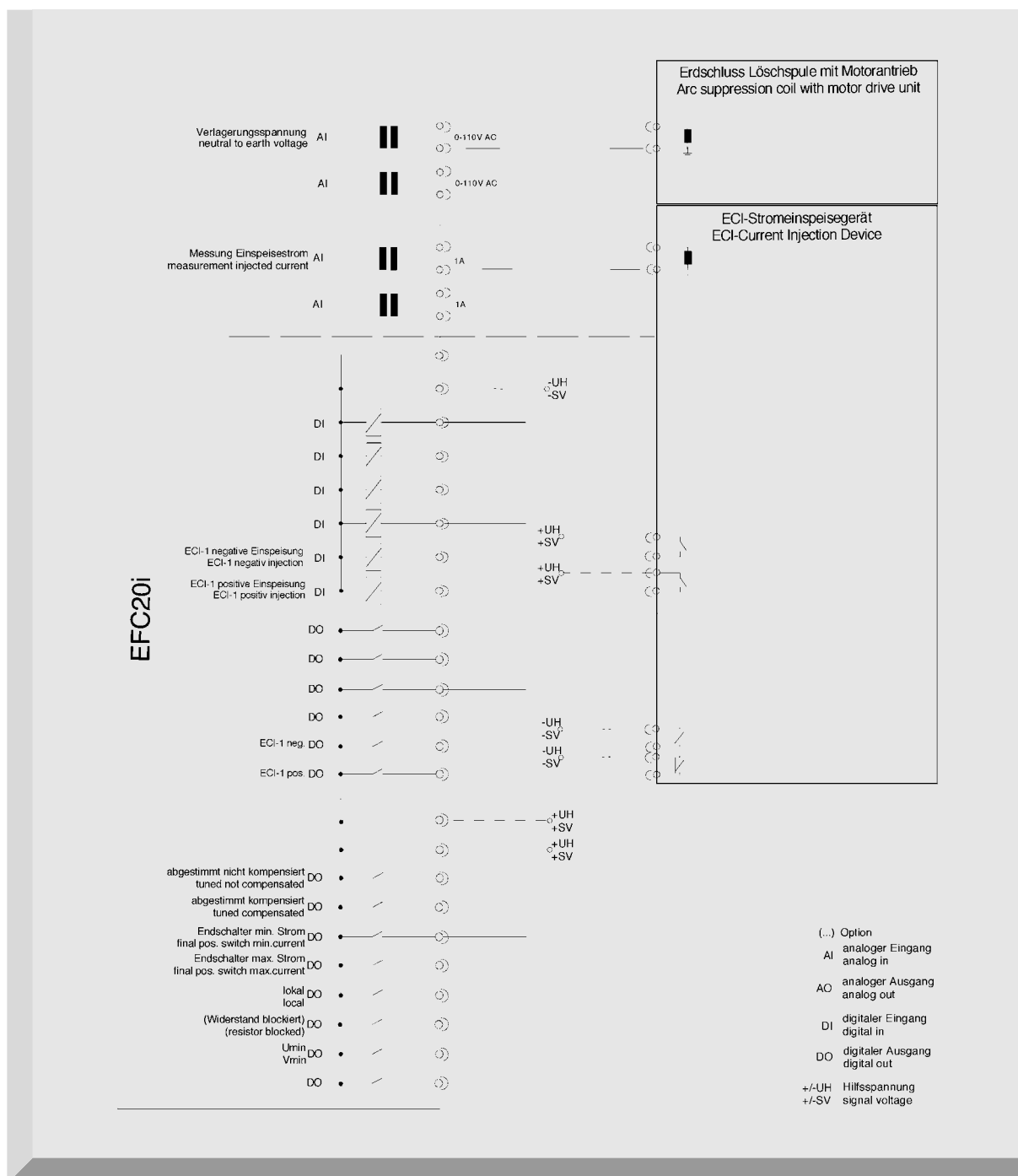


fig. 9 EFC20i wiring diagram - standard, sheet 2/2

**www.trenchgroup.com**



**TRENCH**

- Trench Austria GmbH  
Paschinger Straße 49, Postfach 36  
A-4060 Linz-Leonding/Austria  
Phone +43.732.6793-0  
Fax +43.732.67 13 41  
email sales@trench.at
- Trench Limited  
Instrument Transformer Division  
390 Midwest Road, Scarborough  
Ontario, Canada M1P 3B5  
Phone +1.416.751-8570  
Fax +1.416.751-6952  
email sales@ca.trenchgroup.com
- Trench Limited  
Coil Product Division  
71 Maybrook Drive, Scarborough  
Ontario, Canada M1V 4B6  
Phone +1.416.298-8108  
Fax +1.416.298-2209  
email sales@ca.trenchgroup.com
- Trench France S.A.  
16, rue du Général Cassagnou  
B.P. 70  
F-68302 St-Louis/France  
Phone +33.3.89 70 23 23  
Fax +33.3.89 67 26 63  
email sales@trench.fr
- Trench Germany GmbH  
Nürnberger Straße 199  
D-96050 Bamberg/Germany  
Phone +49.951.1803-0  
Fax +49.951.1803-224  
email sales@trench.de
- Trench Switzerland AG  
Lehenmattstraße 353  
CH - 4052 Basel/Switzerland  
Phone +41.61.315 51 11  
Fax +41.61.315 59 00  
email sales@trench-tsf.com
- Trench (UK) Limited  
South Drive  
Hebburn  
Tyne & Wear  
NE 31 1 UW, Great Britain  
Phone +44-191-483-4711  
Fax +44-191-430-0633  
email sales@trench-uk.com
- Trench Brasil LTDA  
Via Expressa de Contagem, 2685  
CEP 32370-485  
Contagem, Minas Gerais/Brasil  
Phone +55.31.391-5959  
Fax +55.31.391-1828  
email trenchbrasil@ca.trenchgroup.com
- Trench China Limited  
3658 Jiang Cheng Road  
Minhang, Shanghai 200245  
P.R. China  
Phone +86.21.64630088  
Fax +86.21.64637828  
email sama@trenchcn.com