Transformer Switching
Transformer Soft Starter
Type TSE6-1A.....

- **Soft starting/switching of 1-phase transformers**
- **Rated operational voltage: up to 500 VAC, 50/60 Hz**
- **Rated operational current: up to 63 A**
- **LED-indication for operation and alarm**

Product Description

The transformer soft starter TSE6-1 is an electronic relay with a new integrated soft start procedure which switches on single phase transformers without inrush current. It can either be transformer with EI-cut strip-wound core or toroidal core with any secondary load or it can be a parallel connection of different types of transformers. The soft start procedure used is patented and works with the premagnetisation of the transformer.

The TSE6-1 is available in three different versions: As compact version up to 16 A with internal thyristor and bypass relay or as control unit in combination with external thyristors or semiconductor relay with bypass contactor for high currents (> 16 A).

Ordering Key

TSE6-1A3213100

- **Transformer soft starter**
- **Application**
- **Rated operational voltage**
- **Rated operational current**
- **Remote-On input**
- **Output signal**
- **Detection mains voltage deformation**
- **Special version**

Type Selection

Application	Rated operational voltage	Rated operational current	Remote-On input
A: 1-phase transformer	1: 110 VAC (90-135 VAC) 2: 230 VAC (160-270 VAC) 3: 400 VAC (280-440 VAC) 4: 500 VAC (350-550 VAC)	1: < 16 A 2: > 16 A (with ext. thyristor module)	1: 4-32 VDC

Selection Guide

Rated operational voltage	Rated operational current < 16 A	Rated operational current > 16 A (with ext. thyristor module)
110 VAC (45-65 Hz)	**TSE 6-1A1113100**	**TSE 6-1A1213100**
230 VAC (45-65 Hz)	**TSE 6-1A2113100**	**TSE 6-1A2213100**
400 VAC (45-65 Hz)	**TSE 6-1A3113100**	**TSE 6-1A3213100**
500 VAC (45-65 Hz)	**TSE 6-1A4113100**	**TSE 6-1A4213100**

CARLO GAVAZZI

General Specifications

Type of construction	Encapsulated, Euronorm housing
Environment	
Degree of protection	IP 20
Pollution degree	2 (IEC 60664)
Ambient temperature	0° to +50°C (32° to -122°F)
Protection against surges	Type B-circuit breaker for rated operational current. When using a mismatched or oversized circuit breaker regarding speed and sizing the TSE6-1 can be damaged by means of overload or short-circuit
Pick-up time	Approx. 0.3 (EI-core) - 1.8 s (Toroid core) after mains-On Approx. 0.1 (EI-core) - 0.5 s (Toroid core) with remote-On In special cases 0.02 - 0.04 s remote-On is possible
Max. switching rate	Not limited
Remote-On input	4 - 32 V (DC) U_{max} = ±40 V, I_{min} = 1 mA (by 4 V), I_{max} = 12 mA (by 32 V). The input is galvanically separated by means of opto-coupler. Selection of remote-On/remote Off via internal jumper (factory set jumper position is “remote-On”).
Output signal	Open-Col.-output, potential-free I_{max} = 50 mA, U_{max} = 70 V

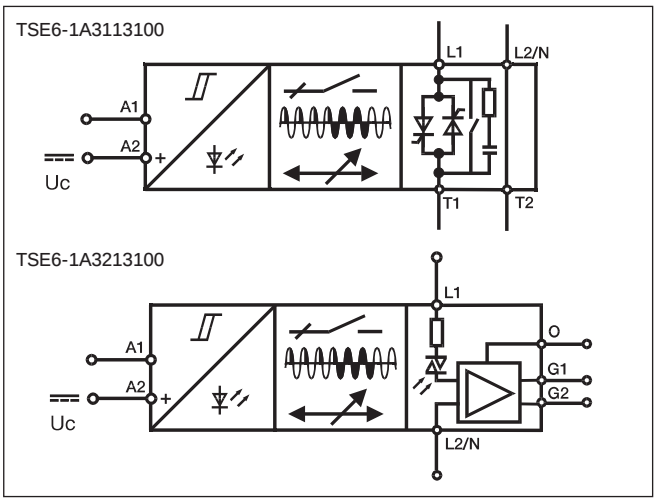
Mode of Operation

The TSE6-1 is used for soft-starting of 1-phase transformers. The factory is delivering the TSE6-1 calibrated for transformers with EI, MI-, resp. UI-cores. The adaptation for other transformer types is possible by adjusting the build-in selector. The TSE6-1 can be controlled either with a direct voltage, comparable to a solid state relay or in another version with a volt-free contact. The signal output (Hi, Lo) is conductive as soon as the TSE6-1 has fully switched on after the premagnetisation of the transformer. A green LED is indicating the status of the signal output. With the bypass relay resp. contactor the control unit is short-circuited directly after switching on to avoid energy loss. When using thyristors or semiconductor relays with heatsink the bypass relay resp. contactor is not needed. The TSE6-1 recognizes itself whether a bypass contactor is connected or not.

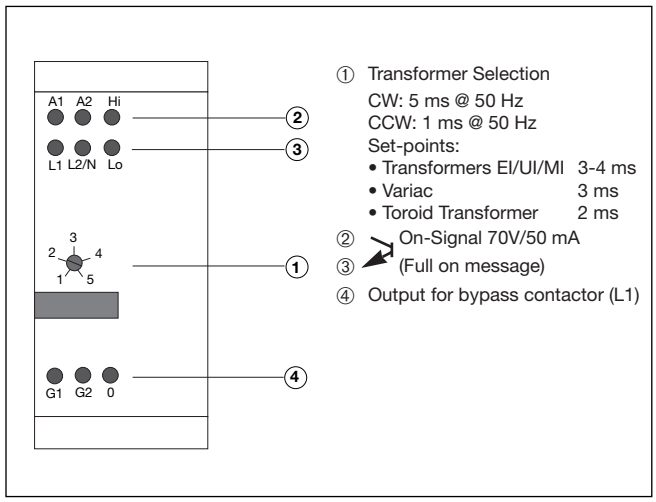
The TSE6-1 controls the main voltage and turns off if the voltage limiting values are exceeded. The red LED blinks with a frequency of 1 Hz in case of undervoltage and with 4 Hz frequency in case of overvoltage. If there is an internal fault the red LED is continuously on.

An internal jumper (J1) is calibrating whether the TSE6-1 is switching on itself after a fault (default position) or if it has to be returned by taking away the mains voltage or the remote-On signal.
As an option the TSE6-1 has the possibility of reacting to mains voltage deformations (loop failures, short power failures) which cause saturation current in the transformer, releasing the fuse of the transformer by turning off the TSE6-1 and the transformer before the saturation currents occur and then directly switching on again the transformer with the standard soft-start procedure.

Functional Diagrams

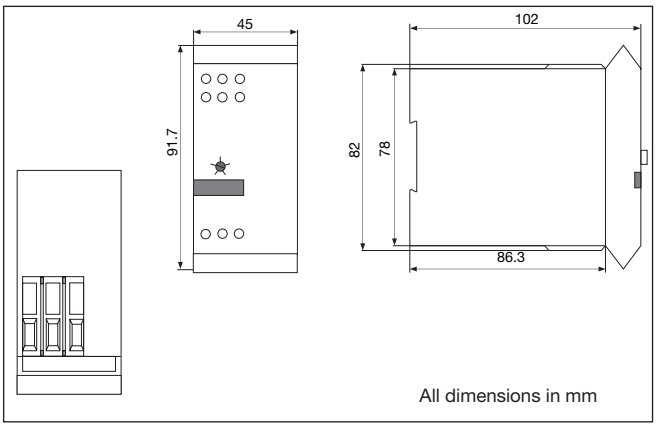


Operation Diagram



CARLO GAVAZZI

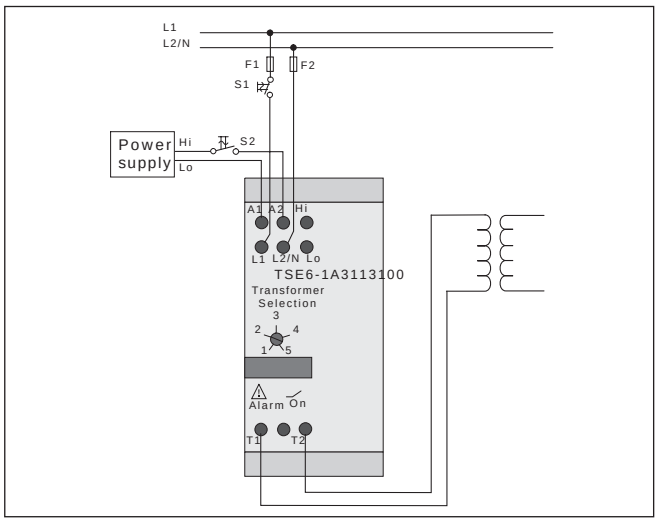
Dimensions



Housing Specifications

Weight	270 g
Housing material Colour	PC/ABS Blend grey
Terminal block Colour	PBTP black
Bottom clip Colour	POM black
Diode cover Colour	PC black transparent
Front knob Colour	PC black
Terminals	Screw terminals

Wiring Diagram



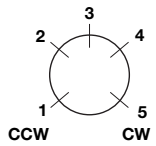
- A main switch is not required when using the remote-On input for switching on/off.
- F1, F2 are fast fuses for operational current or circuit breakers with B characteristic.
- F2 can be eliminated when TSE6-1 is connected to L1 and N.

LED fault indication (red)
Blinks with 1 Hz frequency when voltage too low
Blinks with 4 Hz frequency when voltage too high
Continuous output when internal fault

LED switched ON (green)
Flashing when transformer switched on

Transformer Selection

The size of pre-magnetisation of the transformer can be adjusted by the tuning knob ① named transformer selection.



CW: T/4 (5 ms at 50 Hz)
CCW: T/20 (1 ms at 50 Hz)

Tuning Type of transformer	Position
Transformer (EI-, UI-MI-core)	3-4
Variac	3
Toroid transformer	2

Caution: The TSE6-1 contains thyristors. When TSE6-1 is turned off there is no galvanic separation between transformer and mains supply.

Jumper J1
(inside, on PCB)
When jumper J1 is closed, TSE6-1 switches ON automatically after a fault (high-/low-voltage, technical fault). When jumper J1 is open, TSE6-1 switches ON only when remote-ON resp. mains is switched OFF and ON again.

Default setting: jumper J1 closed.

Jumper J2
(inside, on PCB)
When jumper J2 is closed, TSE6-1 switches ON without remote-ON signal. When jumper J2 is open, TSE6-1 switches ON only when remote-ON signal is ON.

CARLO GAVAZZI

External Thyristor-Modules RTH.

When current > 16 A the TSE6-1 must be used in combination with one of the three thyristor modules RTH1, RTH2 or RTH3. In these thyristor modules gate-cathode diodes (e.g. 1N4007), gate-cathode-resistor and the RC-part (47Ω/150 nF) are already integrated. For this reason these thyristor modules can be connected to the TSE6-1 without any restrictions.

Correctly dimensioned heat-sinks are already integrated in the thyristor-modules.

The turn on is made by opto-triacs (Sitac) via a resistor (160 Ω) from the anode side of the thyristor.

Max. gate current	I_{GT}	=	220 mA
Max. perm. delay on turn on	t_{gd}	=	200 µs
Max. perm. reset time	t_q	=	250 µs
Gate-cathode resistor	R_{GK}	=	120 Ω/0,25 W
Gate-cathode diode	D_{GK}	=	z.B. IN4007

General Specifications RTH.

Operational voltage range	42 to 530 VAC
Non-rep. peak voltage	1200 V_p
Varistor voltage	510 VAC
Operational frequency range	45 to 65 Hz
Power factor at rated voltage	≥ 0.5
CE-marking	Yes

Thermal Specifications RTH.

	RTH1	RTH2	RTH3
Operational temperature	-20° to +70°C (-4° to +158°F)	-20° to +70°C (-4° to +158°F)	-20° to +70°C (-4° to +158°F)
Storage temperature	-20° to +70°C (-4° to +158°F)	-20° to +70°C (-4° to +158°F)	-20° to +70°C (-4° to +158°F)
Junction temperature	< 125°C (257°F)	< 125°C (257°F)	< 125°C (257°F)
R_{th} juntion to ambient (AC load)	2.8 K/W	2.8 K/W	2.8 K/W

Output Specifications RTH.

	RTH1	RTH2	RTH3
Rated operational current			
AC 1 @ Ta = 30°C	30 A	50 A	63 A
@ Ta = 40°C	25 A	50 A	60 A
@ Ta = 50°C	23 A	38 A	55 A
@ Ta = 60°C	20 A	30 A	50 A
AC 3 @ Ta = 60°C	6 A	12 A	24 A
Min. operational current	200 mA	200 mA	200 mA
Rep. overload current t = 1 s (Tj = 25°C)	55 A	125 A	150 A
Non-rep. surge current t = 10 ms (Tj = 25°C)	250 A_p	600 A_p	1000 A_p
Off-state leakage current @ rated voltage and frequency (Tj = 125°C, max.)	< 1 mA	< 1 mA	< 1 mA
I^2t for fusing t = 1 to 10 ms	310 A^2s	1800 A^2s	5000 A^2s
Critical dV/dt	500 V/µs	500 V/µs	500 V/µs

CARLO GAVAZZI

Housing Specifications RTH.

Mounting	DIN-rail 35 mm
Weight RTH1	450 g
Weight RTH, RTH3	750 g
Housing material	Glass reinforced noryl SE1FGFN1
LED-window material	PC Lexan 141 R
Base plate	Aluminium, nickel plated
Potting compound	Polyurethan, casco nobel
Terminals	Screw with captive wire clamp
Control terminals nominal	4 mm^2 or 2 x 2.5 mm^2 AWG 12 or 2 x AWG 14
Min.	0.5 mm^2, AWG 20
Mounting torque max.	0.6 Nm
Power terminals nominal	10 mm^2 or 2 x 6 mm^2 AWG 6 or 2 AWG 10
Min.	1 mm^2, AWG 16
Mounting torque max.	2.0 Nm
Heatsink compound used	Dow Corning 340

Insulations RTH.

Rated impulse withstand volt.	
Input to output	4000 V_{rms}
Output to heatsink	4000 V_{rms}

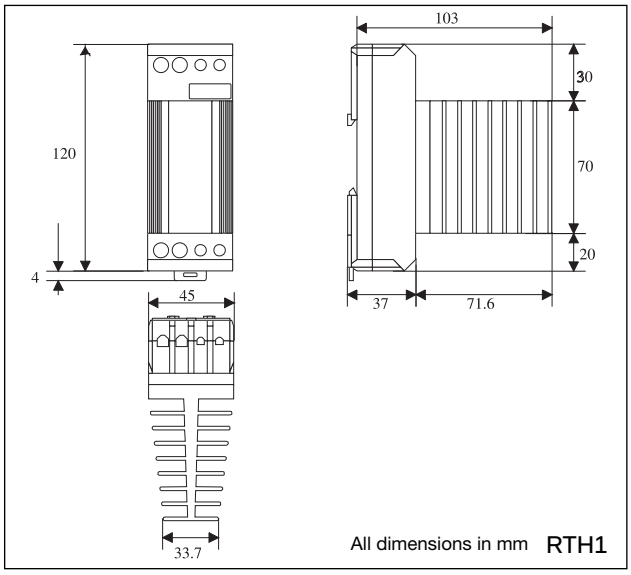
Environment Specifications RTH.

Humidity max.	95%, no condensation

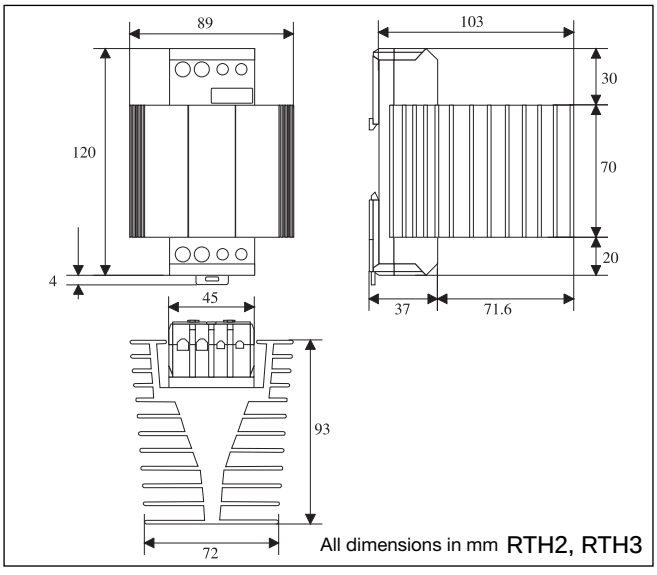
Dimensions RTH.

Dimensions (H x W x D)	
RTH1	120 x 45 x 110 mm
RTH2, RTH3	120 x 90 x 110 mm

Dimensions RTH.



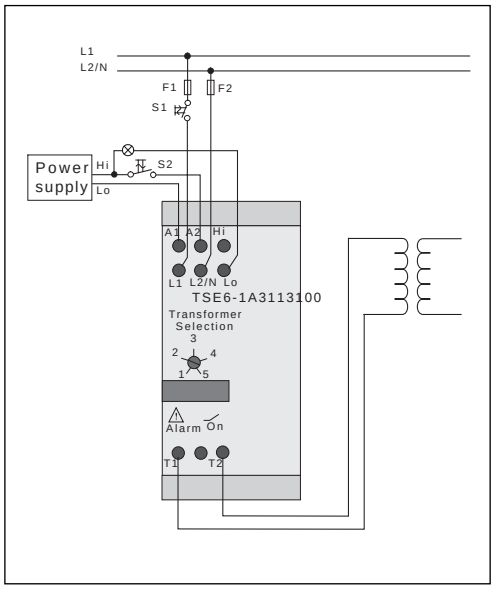
All dimensions in mm RTH1



All dimensions in mm RTH2, RTH3

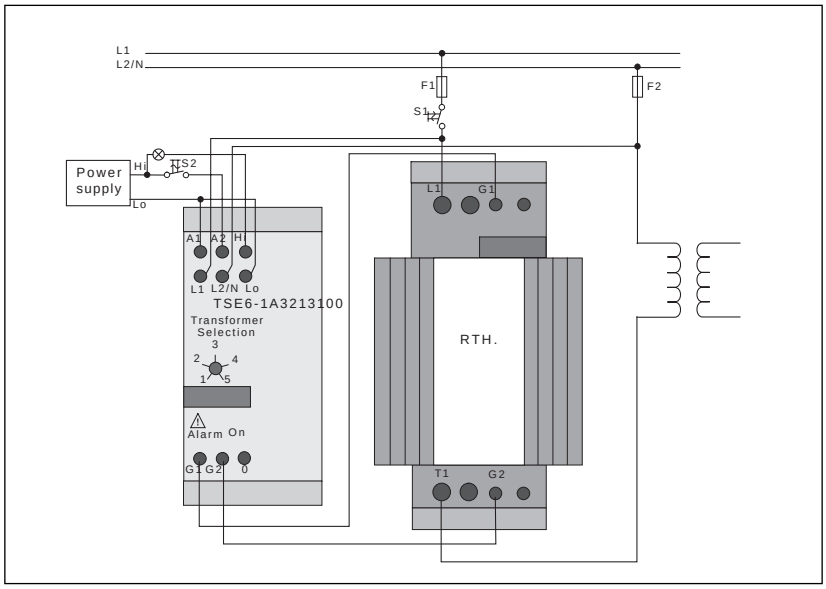
Wiring Examples

TSE6-1A.2 soft starter for transformers with any load.



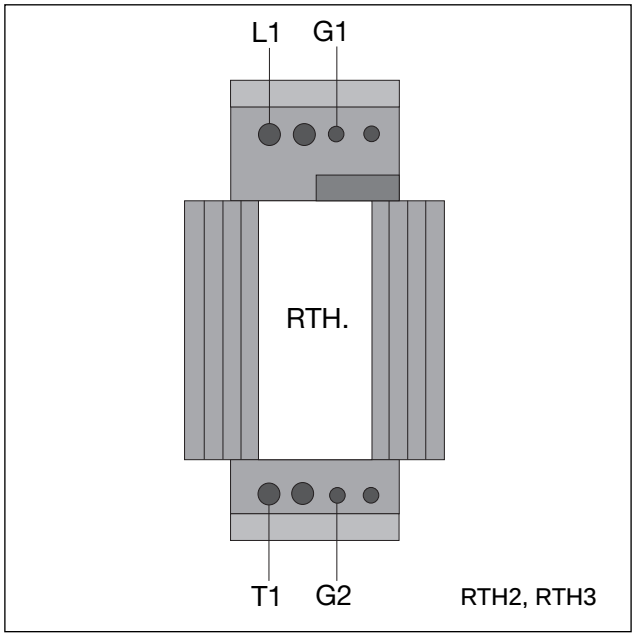
- Switch ON/OFF with S1 and/or S2 via remote-ON input.
- F2 is not required, when TSE6-1 is connected to L1 and N.

TSE6-1A.1 soft starter in combination with external thyristor module for transformers with load > 16 A.



- Switch ON/OFF with S1 and/or S2 via remote-ON input.
- F2 is not required, when TSE6-1 is connected to L1 and N.
- Bypass contactor not required when thyristor-module with heatsink is used.

Connections RTH.



Bypass-Contactor *)

TSE6-1 detects automatically if a bypass contactor is connected.

Peak load of contacts (AC1)	$I_{kac1} = I_{load}$
Coil voltage	
When TSE6-1 working with U_{L1N}	$U_{BSSP} = U_{L1N}$
When TSE6-1 working with U_{L1L2}	$U_{BSSP} = U_{L1L2}$ or U_{L1N}

*) Only used with external thyristor-module or with SSR