INDUCTION MOTOR SOLID-STATE REDUCED VOLTAGE STARTER (SOFTSTARTER) WITH SOFTSTOP FEATURE

The Series EMC can be used as an alternative to costly and relatively big variable speed controllers in applications such as pumps, fans, compressors and conveyors.

Its six-thyristor structure, working like a full-wave phase angle controller (both positive and negative cycles are controlled), reduces the induction motor starting current as well as the motor starting torque. The reduction in motor starting current improves the efficiency of the power used. It also avoids voltage fluctuations that lead to ambient light variations or "flicker."

The Series EMC fits existing applications without any modification of the wiring field configuration. Thus it can replace an electromechanical star-delta starter without changing the motor coupling. The EMC may be implemented like a standard three-phase electromechanical contactor for induction motors. Furthermore, its ability to be installed inside the delta wiring allows the Series EMC to drive 1.73 times more current than a standard on line softstarter.

The Series EMC features diagnostic and self-test functions to assist with machine maintenance, reduce costs, and delays of restarting equipment.
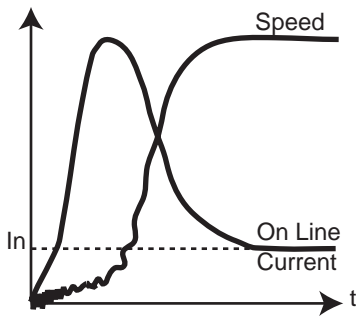
| MAIN CHARACTERISTICS										
Max. Motor Power @40° C				IAC53a @40° C		Phase to Phase Voltage	Mains Frequency	Input	Status Output	In/Out/Case Isolation	Operating Temperature
Star (Y)		Delta (D)								
400Vac	230Vac	400Vac	230Vac	Max.	EN60947-4-2					
2.2kW	1.3kW	3.8kW	2.2kW	5A	3.5A	200 to 480Vac	40 to 65Hz	10 to 24Vdc	24V/1A AC/DC	4kV	− 40° C to +100° C

BENEFIT FOR MOTOR STARTING

DIRECT ON LINE (DOL) STARTING

- **Mechanical part stress**
  - Noise
  - Maintenance costs
- **High inrush current**
  - Motor and mains protection oversized
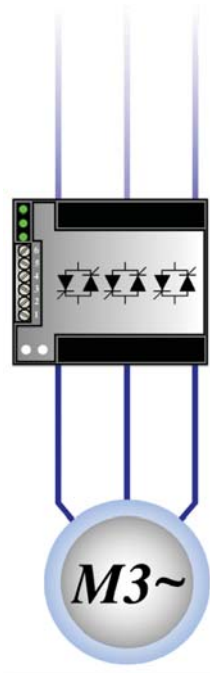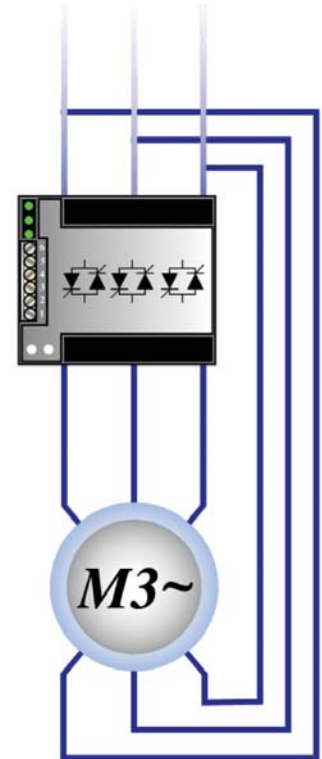 - Risk of flicker

SOFTSTARTING WITH EMC
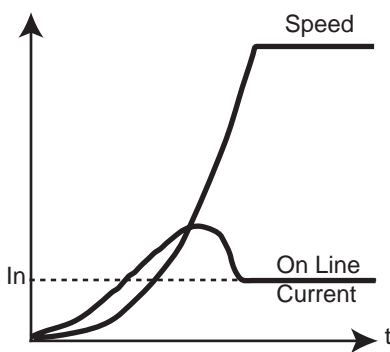
- **Softstarting**
  - Noise reduction
  - Maintenance cost reduction
- **No more high inrush current**
  - Motor and mains protections optimization
  - No more harmonic or flicker problems

TYPICAL WIRINGS

STAR (Y)

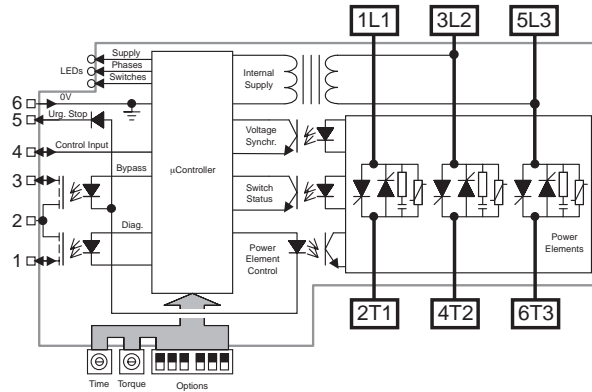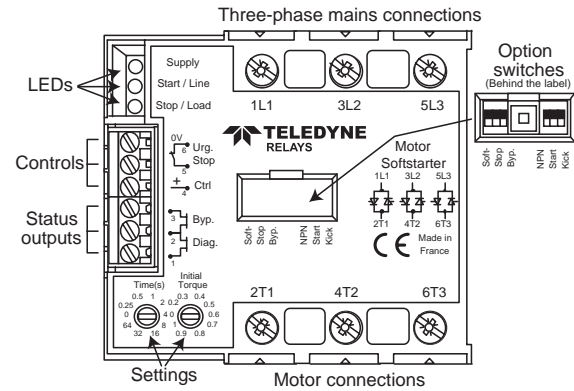**DELTA (D)**

SETTINGS AND DIAGNOSTIC

Fig. 1	INTERNAL DIAGRAM

Fig. 2	DESCRIPTION

DESCRIPTION OF THE CONNECTIONS

Terminals	1 & 2	2 & 3	4 & 6	5 & 6	1L1, 3L2, 5L3	2T1, 4T2, 6T3
Function	Diagnostic	Bypass	Control	Urgent stop	Three-phase mains (Obligatory)	Motor supply (Obligatory)
Input/Output	Output	Output	Input	Input	Input	Output
Activated when...	Closed	Closed	High (PNP) or Low (NPN)	Open	3x200Vac	100ms after control
Polarization	NO (AC or DC)	NO (AC or DC)	Yes (4+ / 6–)	Yes (5+ / 6–)	NO (AC)	NO (AC)

DESCRIPTION OF THE SETTINGS AND OPTIONS

Setting/Option	Time	Initial Torque	Soft Stop	Bypass	NPN/Start	Kick
Function	Increasing voltage ramp duration	Min. voltage applied to the motor at start	Decreasing voltage ramp duration	Bypass presence diagnostic option (if bypass used)	Softstarter type of control option	Motor shaft breakaway
Possibilities	Ts=0 up to 64s	0 up to 100%	0, 1/2, 1 or 2 x ts up to 64s max.		PNP, NPN or on mains presence	0 up to 100ms depending on ts
Proceeding						

Fig. 3	DESCRIPTION OF THE DIFFERENT SETTING PARAMETERS

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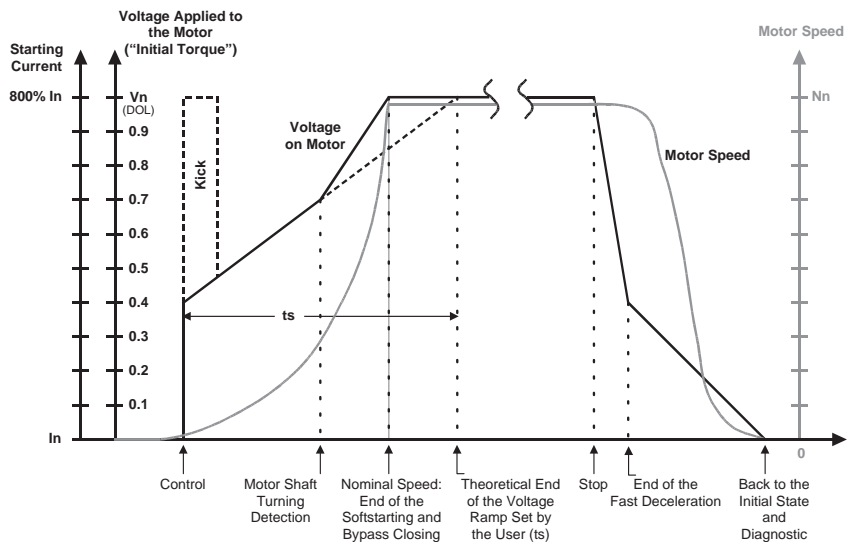
SETTINGS AND DIAGNOSTIC

DESCRIPTION OF THE DIAGNOSTIC INFORMATION IN NORMAL OPERATION

Visualization			Status Output		Motor	Probable Cause
Supply	Line	Load	Bypass	Diag.		
Off	Off	Off	Open	Open	Stopped	No mains or device not correctly wired
Green	Green	Green	Open	Open	Stopped	Mains voltage and phases OK; motor detected; no control
Green	Flashing Green	Off	Open	Open	Starting	Mains voltage and phases OK; motor detected; control detected and beginning of the softstarting ramp
Green	Green	Off	Closed	Open	Running to nominal speed	Mains voltage and phases OK; motor detected; no control detected and end of the softstarting ramp
Green	Off	Flashing Green	Open	Open	Decelerating	Mains voltage and phases OK; motor detected; no control detected and beginning of the softstopping ramp

DIAGNOSTICS IN CASE OF FAILURE

Visualization			Status Output		Motor	Possible Cause	Solution
Supply	Line	Load	Bypass	Diag.			
Flashing Red	Off	Flashing Red	Open	Closed	Stopped	Mains voltage too low	Check the phases 3L2 and 5L3
Off	Red	Off	Open	Open	Stopped	Phase(s) missing; mains frequency out of range; too much inteference	Check the phases
Off	Red	Off	Closed	Closed	Running	Phase(s) missing	Check the phases
Off	Red	Red	Open	Closed	Stopped	Load missing; short-circuited thyristor	Check the motor connections and the solid-state switches
Off	Flashing Red	Flashing Red	Open	Closed	Stopped	Bypass missing (its checking is required by the corresponding option)	Check the bypass connections or, if not used, cancel the checking option
Flashing Red	Flashing Red	Flashing Red	Open	Closed	Stopped	The solid-state switches cannot close	Check if the connection between 5 and 6 of the control terminal block is correctly done. Check as well if the load current is sufficient.
Red	Red	Red	Open	Closed	Stopped	Microcontroller malfunction	Disconnect the softstarter from the mains for a while
Flashing Green	Flashing Red	Off	Open	Open	Stopped	A problem occurred on the mains (no voltage or a phase is missing) then disappeared, but the control voltage was applied	Remove the control for a while
Flashing Green	Flashing Red	Flashing Red	Open	Open	Stopped	A problem occurred on the load (temporary disconnection) then disappeared, but the control voltage was applied	Remove the control for a while

LEGEND

Off	Green	Red	Flashing Green	Flashing Red	Open	Closed
○	●	●	●○	●○		

IMPORTANT INFORMATION ABOUT THE DIAGNOSTIC

1. The device makes a complete diagnostic (mains, load and itself) since it has enough supply voltage (On the mains or on the control side).
2. The device only checks the presence of the phases and the closing of the solid-state switches during the voltage ramps (softstart and softstop) and during the full on-state period.
3. The control overrides the diagnostic.
   - If a problem occurs during the control period, the device will close all the solid-state switches. If the problem goes on during the full on-state period, the corresponding information will be given to the user according to the table above.
   - Likewise, if a problem occurs during the softstopping period, the device will stop immediately in order to reach the off-state diagnostic period.
4. On a hard stop (no softstop) and in the case of driving a large motor, the device may temporarily display a problem concerning the mains. This is due to an important residual voltage across the motor windings (back EMF generated by the motor rotation and the remaining magnetic field). This security allows the user to avoid connecting the motor to the mains in bad conditions. This phenomenon can be cancelled by using the softstop feature that slowly reduces the remaining magnetic field inside the motor. This also avoids overvoltage across the solid-state switches (increasing the lifetime expectancy of the integrated varistors). Therefore, softstop is recommended even with high inertia motor loads.

CONTROL

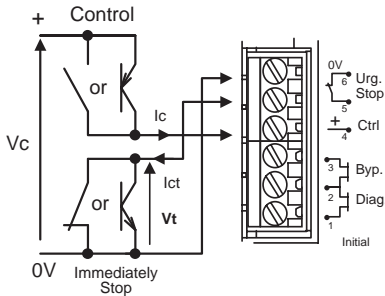### CONTROL INPUTS AND STATUS OUTPUTS

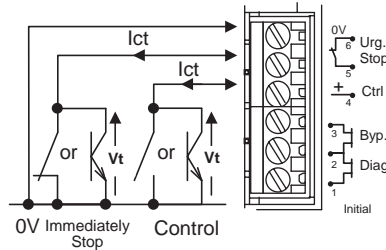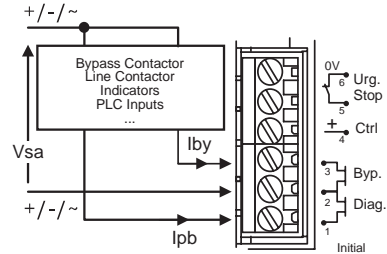| Fig. 4 HIGH SIDE CONTROL (PNP)	Fig. 5 LOW SIDE CONTROL (NPN)	Fig. 6 STATUS OUTPUT UTILIZATION

ELECTRICAL CHARACTERISTICS OF THE STARTING AND STOPPING INPUTS

Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)			Remarks
Input		**Control**		**Urg. Stop**	
Function		Controlling the device		Immediately stop the device	
Control Type (Depending on the option switches)		High side control (PNP)	Low side control (NPN)	Opening the connection to zero volt	
Concerned Terminals		4 & 6	4 & 6	5 & 6	
Control Voltage Range (according to EN60947-4-2)	Vc	10-24Vdc			
Min. Control Voltage	Vcmin.	8.5V			
Max. Voltage Drop	Vt		2.5Vdc	1.5Vdc	
Max. Input Voltage		Vcmax=28Vdc	Vtmax=28Vdc	Vtmax=6Vdc	
Max. Reverse Voltage		Vcmax=28Vdc	Vtmax=28Vdc	Vtmax=6Vdc	
Release Voltage		Vc<1Vdc	Vt>2.5Vdc	Vt>1.5Vdc	
Control Current	Ic	5– 19mAdc			See Fig. 7
Current to Switch	Ict		50-100μAdc	20mAdc	Depends on Vt

STATUS OUTPUT CHARACTERISTICS

Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)		Remarks
Output		**Diag.**	**Bypass**	
Concerned Terminals		1 & 2	2 & 3	
Function		Environment problem detection or faulty device indication	Indicates the end of the starting period and can be used to control a bypass electromechanical contactor	
Nom. Operating Voltage	Vsan	24Vac/dc		
Operating Voltage Range	Vsa	0-28Vac/dc		
Non-Repetitive Max. Peak Voltage	Vsapmax	60V		
Protection Against Overvoltage		Yes; 25V size 7 varistors integrated		See Fig. 11 & 12
Min. Load Current	Ibymin Ipbmin	0		
Max. Permanent Current	Iby/Ipb	1A ac/dc		See Fig. 8
Overload Current	Ibyp/Ipbp	2.4A ac/dc		@100ms 10% of the cycle
Protection Against Short Circuits		No		
On-State Resistance	Ron	500mΩ		See Fig. 9
Off-State Resistance	Roff	100MΩ		
Off-State Capacitance	Coff	130pF		See Fig. 10
Turn-On Time	Toff	0.5ms		
Turn-Off Time	Ton	2ms		

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CONTROL

CHARACTERISTIC CURVES OF THE CONTROLLING INPUTS AND STATUS OUTPUTS

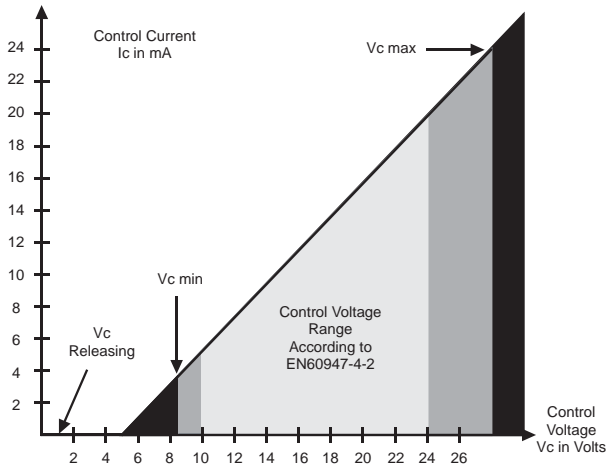**Fig. 7   CONTROL INPUT CURRENT/VOLTAGE CHARACTERISTIC IN PNP MODE (HIGH SIDE CONTROL)**

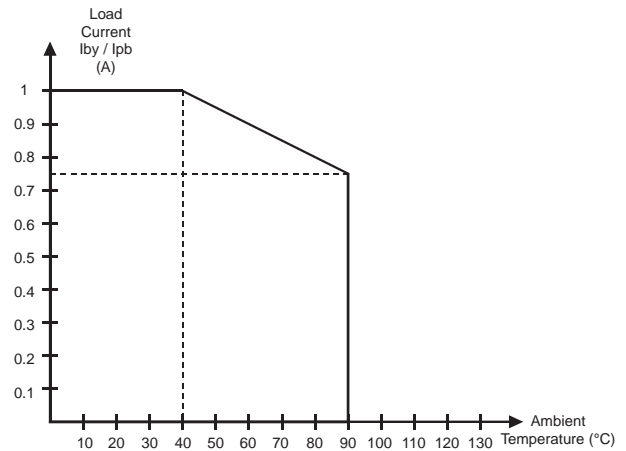**Fig. 8   MAX. OUTPUT STATUS CURRENT VERSUS AMBIENT TEMPERATURE**

Fig. 9   OFF-STATE STATUS OUTPUT PARASITIC CAPACITANCE VERSUS OUTPUT VOLTAGE
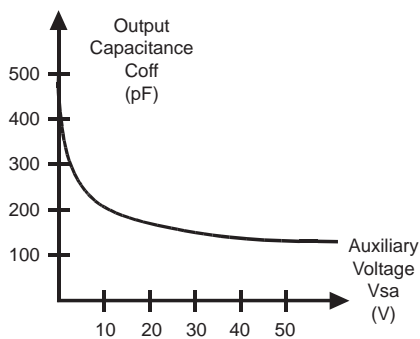

Fig. 10   ON-STATE STATUS OUTPUT RESISTANCE VERSUS AMBIENT TEMPERATURE
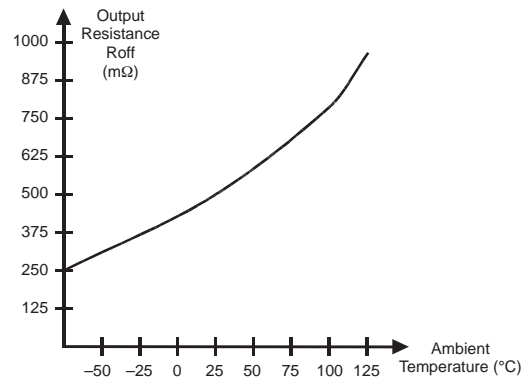

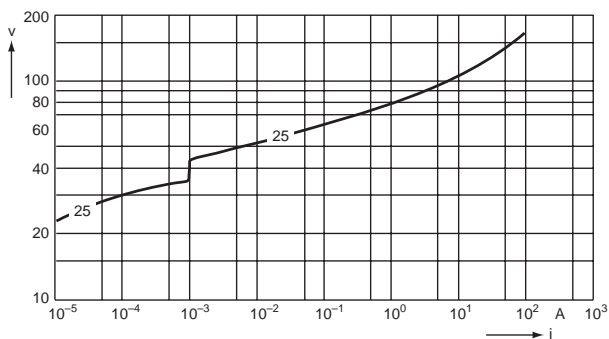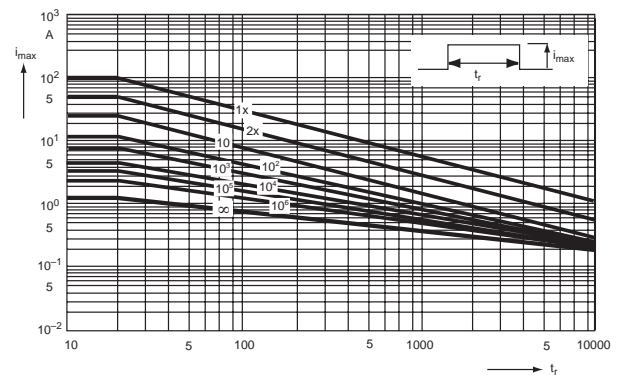**Fig. 11   STATUS OUTPUT OVERVOLTAGE PROTECTION CHARACTERISTIC**

Fig. 12   MAX. OVERLOAD PULSES REGARDING DURATION FOR OVERVOLTAGE PROTECTION OF STATUS OUTPUTS

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POWER

INTERNAL SUPPLY ELECTRICAL CHARACTERISTICS			
Characteristics	**Labels**	**Values** (Given at 20° C ambient unless otherwise specified)	**Remarks**
Concerned Terminals		3L2 & 5L3	See Fig. 1
Voltage Range	Ve	200-480Vac	
Consumption	Is	1mA typical	
Frequency Range	f	40-65Hz	
Turn-On Time	tm	100ms	

POWER SIDE CHARACTERISTICS			
Characteristics	**Labels**	**Values** (Given at 40° C ambient unless otherwise specified)	**Remarks**
Concerned Terminals		1L1, 2T1, 3L2, 4T2, 5L3, 6T3	
Max Power of the Motor @400VAC Star Wiring (Y)	Pn	2.2kW	
Max Power of the Motor @230VAC Star Wiring (Y)	Pn	1.3kW	
Max Power of the Motor @400VAC Delta Wiring (D)	Pn	3.8kW	Device wired inside the delta
Max Power of the Motor @230VAC Delta Wiring (D)	Pn	2.2kW	Device wired inside the delta
Nom. Operating Voltage	Ven	230Vac & 400Vac	
Operating Voltage Range	Ve	200-480Vac	
Max. Non-repetitive Peak Voltage	Vep	1200V	
Integrated Overvoltage Protection		Yes 510V size 14 varistors	See Fig. 16 & 17
AC53a Nom. Current according to EN60947-4-2 (Induction Motor)	Ie (AC53a)	3.5A	Hard conditions See Fig. 15
AC53a Max. Permanent Current (Induction Motor)	Ie (AC53a)	5A	Normal conditions See Fig. 15
Max. AC1 Permanent Current (Resistive Loads)	Ith (AC1)	5A	e.g. softstarting lamps
Non-repetitive Peak Overload Current (1 cycle of 10ms)	ITSM	550A	See Fig. 14
Fusing Limit Current for Choosing the Protecting Fuses	I²t	1500A²s	@10ms
Min. Load Current	Iemin	100mA	
Max. Leakage Current	I1k	7mA	@400Vac 50Hz
Power Factor	Pf	0-1	
Operating Mains Frequency Range	F	40-65Hz	
Off-state dv/dt	dv/dt	500V/μs	
Integrated Transient Voltage Protection		Yes RC network	
Max. Current Rising Time	di/dt	50A/μs	
Direct Voltage Drop	Vd	1.4V	@Ith
Resistive Part of the Direct Voltage Drop	rt	12mΩ	@125° C
Threshold Part of the Direct Voltage Drop	Vto	0.9V	@125° C
Max. Junction Temperature	Tjmax	125° C	
Junction/Plate Thermal Resistance Per Power Element	Rthjc	0.45° K/W	Total = 3 power elements
Plate/Heatsink Thermal Resistance	Rthcs	0.05° K/W	
Vertically Mounted Heatsink Thermal Resistance	Rthra	4° K/W	@ΔTra=60° C
Heatsink Thermal Time Constant	Tthra	15min	@ΔTra=60° C

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

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POWER

CHARACTERISTIC CURVES OF THE POWER ELEMENTS

Fig. 13   ELECTRICAL LABEL DESCRIPTION

Three Phase Mains
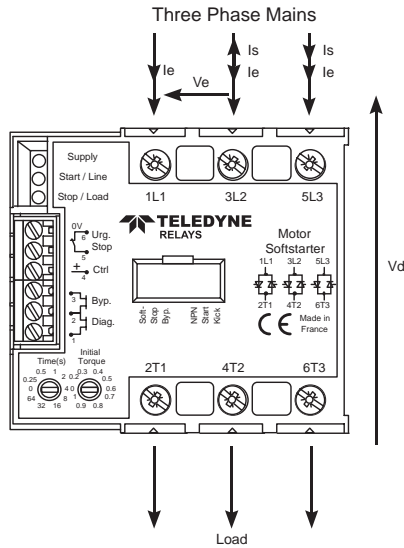
Load

Fig. 14   OVERLOAD CURRENT CHARACTERISTIC REGARDING OVERLOAD DURATION

ITSM (A) (Peak Values)

Non-repetitive

Repetitive

Time(s)
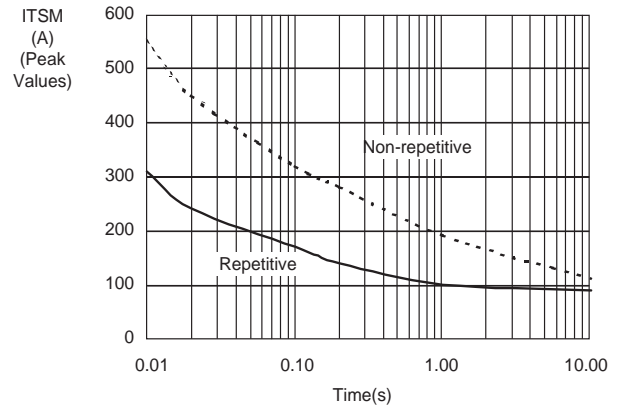
Fig. 15   NOMINAL CURRENTS VERSUS AMBIENT TEMPERATURE

AC53a Permanent Current Ie (ARMS)

Limit for heat sink temperature below 100°C

Limit for heat sink temperature below 80°C in compliance with the standard EN60947-4-2

Dissipated Power (W)

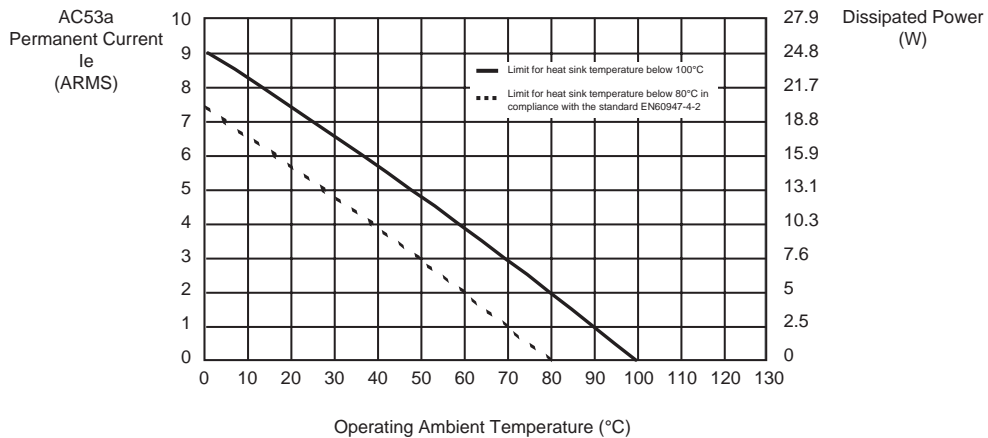Operating Ambient Temperature (°C)

Fig. 16   OVERVOLTAGE PROTECTION CHARACTERISTIC (VARISTORS)
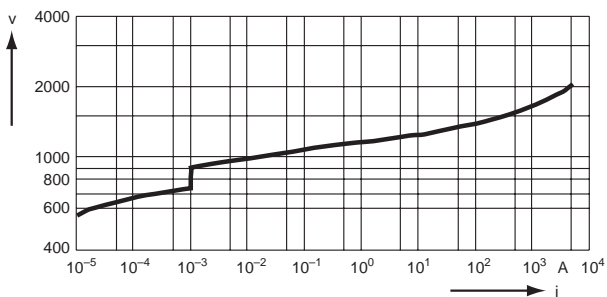
Fig. 17   MAX. OVERLOAD PULSES REGARDING DURATION FOR OVERVOLTAGE PROTECTION OF POWER ELEMENTS

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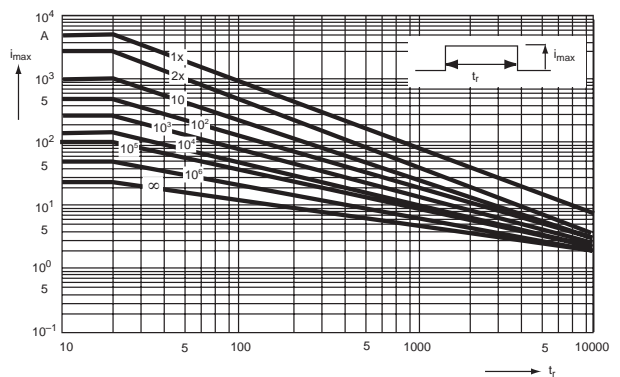
GENERAL

INPUT/OUTPUT ISOLATION CHARACTERISTICS

Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)	Remarks
Power Output/Input Isolation	Vimp	4Kv	
Status Outputs / Input Isolation	Vied	2.5Kv	
Plate/Input Isolation	Vimp	4Kv	
Status Output/Plate Isolation	Vimp	4Kv	
Isolation Resistance	Rio	1GΩ	
Isolation Capacitance	Cio	<8pF	

CLIMATIC OPERATING ENVIRONMENT

Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)	Remarks
Storage Ambient Temperature	Tstg	– 40 to 100° C	
Ambient Operating Temperature	Tamb	– 40 to 90° C	
Max Heat Sink Temperature	Tc	100° C	
Wet Heat Resistance (Continuous)		According to I.E.C. 68 parts 2 & 3	
Wet Heat Resistance (Cyclical)		According to I.E.C. 68 parts 2 & 30	

CONNECTIONS AND REQUIRED TOOLS ON THE CONTROL SIDE

Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)	Remarks
Connections		Screwed	
Screwdriver		0.8 x 2mm	
Wire Cross Section		2.5mm^2	
Min. & Max. Tightening Torque			

CONNECTIONS AND REQUIRED TOOLS ON THE POWER SIDE

Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)	Remarks
Connections		Screwed	
Screwdriver		Posidriv 2 or 0.8 x 5.5mm	
Wire Cross Section		1.5-6mm^2 (10mm^2 without ferrule)	
Min. & Max. Tightening Torque		1.8 to 3N.m	
Possible Number of Connected Wires for the Max. Cross Section		2	

CHARACTERTISTICS AND REQUIRED TOOLS FOR THE SETTINGS

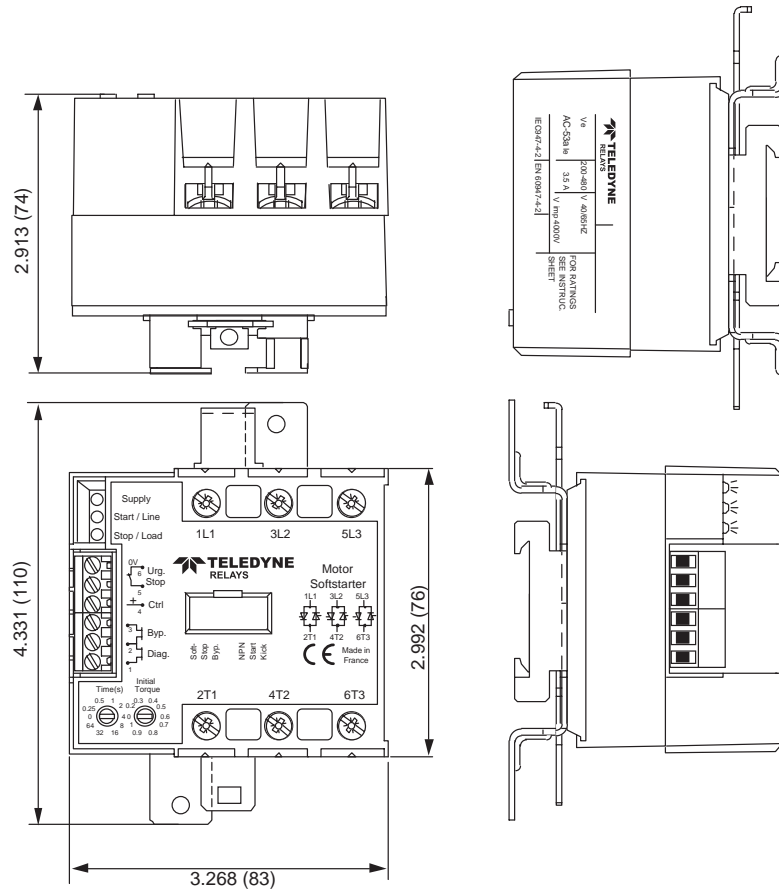| Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)		Remarks
Setting		"Time" and "Initial Torque"	Option Switches	
Screwdriver				
Number of Postions		10	2 for each switch	
Changing Position Required Torque		>1.5N.cm +/– 50%	>3N.cm +/– 50%	Rotary switches: No rotation stop
Angle Between Each Position		36°	0°	

MISCELLANEOUS CHARACTERISTICS

Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)	Remarks
Housing		UL94V0	
Mounting		Omega DIN rail (DIN50022) or screwed	
Noise Level		Low audible vibration during the softstarting and softstopping periods	
Weight		21.16 oz. (600g)	

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GENERAL

Fig. 18	DIMENSIONS

CHARACTERISTICS OF THE THERMAL PROTECTION			
Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)	Remarks
		Not available with this reference	

CHARACTERISTICS OF THE FAN			
Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)	Remarks
		Not available with this reference	

STANDARDS

IMMUNITY LEVEL WITHIN ELECTROMAGNETIC COMPATIBILITY (E.M.C.)

Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)	Remarks
Electrostatic discharges	EN 61000-4-2	8kV in the air 4kV contact	No state changing or destruction
Radiated Electromagnetic Fields	EN 61000-4-3	10V/m	No state changing or destruction
Fast Transient Bursts	EN 61000-4-4	2kV direct coupling on the power side 2kV clamped coupling on the input side	No state changing or destruction
Electric Shocks	EN 61000-4-5	1kV direct coupling differential mode (Input and output sides) 2kV direct coupling common mode (Input and output sides)	No state changing or destruction
Voltage Drop	EN 61000-4-11		

EMISSION LEVEL WITHIN ELECTROMAGNETIC COMPATIBILITY (E.M.C.)

Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)	Remarks
Conducted Disturbances	EN55011	In compliance with the standards for industrial field In compliance with the standards for domestic field with an external bypass contactor	
Radiated Disturbances	EN55011	<30dbμV for the frequency range 30– 230MHz <37dbμV for the frequency range 230– 1000MHz	
Remarks Concerning Filtering		The conducted or radiated disturbances generated by solid-state relays depend on the wiring and load configuration. The test method recommended by the European standards concerning electromagnetic compatibility leads to results far from reality. We recommend use of filters based on your application. The European standard EN60947-4-2 requires the measurement to be done at full on state (end of the softstarting period). Therefore, our products are below the industrial field required levels on inductive load like the induction motor and no additional filter is needed. The starting period that may last several minutes generates enough interference to disturb sensitive devices located near the softstarter.	

LOW-VOLTAGE DIRECTIVE

Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)	Remarks
Standard		EN60947-4-2	
Protection Level	IP	2L0	
Protection for Direct Touch		According to V.D.E. 160 part 100; Back hand and finger safety	

APPROVALS

Characteristics	Labels	Values (Given at 20° C ambient unless otherwise specified)	Remarks
CE Marking	EN 60947-4-2	Yes	
c UL US	UL508	Pending	
VDE 0805	EN60950	Pending	Office environment

STANDARDS

IMPORTANT

DANGER!

The installation of this product must be done by **qualified people**, informed about electric hazards (electrocution risks linked to the voltage levels in the circuit).

Any intervention on the installation must be operated with the circuit disconnected from the electric grid by an electromechanical mean insuring a sufficient galvanic isolation.

The EMC is composed of silicon-based solid-state switches. **They never ensure a safe function when they are not controlled** (important leakage current and untimely closing). Therefore, we advise you to use an electromechanical device in series with the softstarter, which can ensure a safe operation in the disconnected circuit.

The emergency stop must not be done by the softstarter. It must be done by an electromechanical mean with sufficient current breaking possibility.

In order to operate the circuit safely, the control part of the softstarter will have to be disconnected from the control or auxiliary supplies as well.

ATTENTION

1. **The *EMC* does not correctly operate on three-phase mains with the motor neutral connected to the neutral of the mains. If you have such a requirement, please contact us.**
2. The overload relay must be adapted to the motor.
3. Please take care not to make short circuits while installing the bypass contactor or the backward wires for delta wiring.
4. In case of devices planned to be used connected to a bypass contactor, the control voltage will have to be held sufficiently to allow the bypass to close. Verify the bypass checking option "byp."
5. In case of fast softstarting and softstopping controls without waiting for the end of the ramps, the motor may heat up. Please contact your motor supplier to choose an adapted model.

ENVIRONMENT OF THE SOFTSTARTER			
Devices	**Labels**	**Description**	**Remarks**
On Line Fuses (Hard conditions according to EN60947-4-2)		FERRAZ 14 x 51 am 12/500V	
On Line Fuses (Normal conditions)		To be determined by the user	
Overload Relay (Hard conditions according to EN60947-4-2)		Moeller Z00-6 class 10A	
Overload Relay (Normal conditions)		To be determined by the user	
Breaking Capability of the Bypass Contactor	KM1	3.5A AC1	
Bypass Contactor Coil	A1/A2	15VAmax. / 15W max.	
Thermal Protection	T° C	Not available	
Wiring / Settings		Comply with the characteristics given in general information	

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WIRING POSSIBILITIES

| Fig. 19 | HIGH SIDE CONTROL (PNP) |

| Fig. 20 | LOW SIDE CONTROL (NPN) |

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RELAYS

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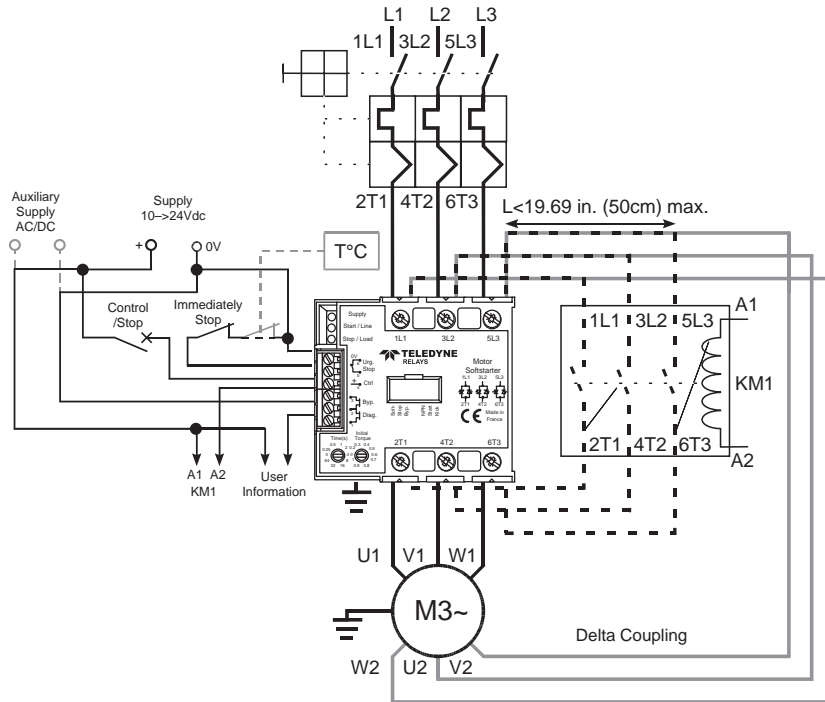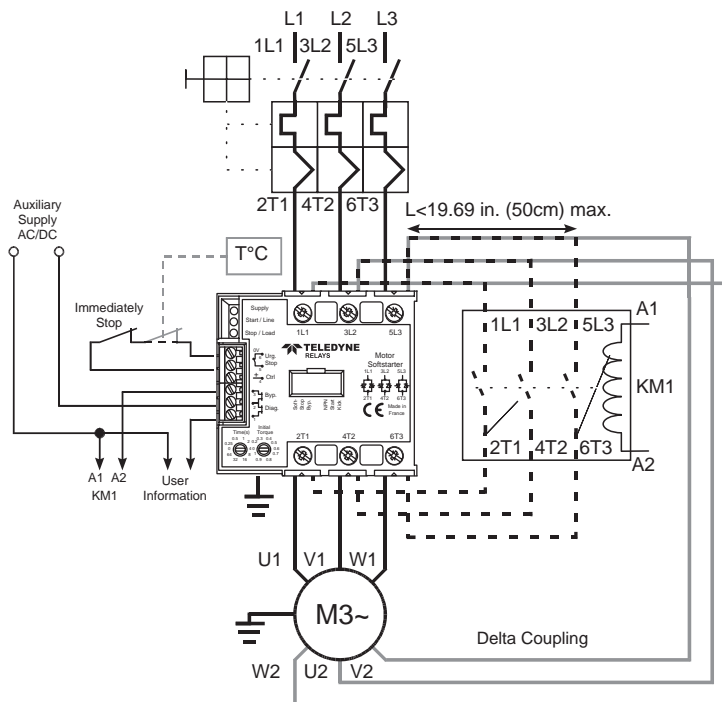
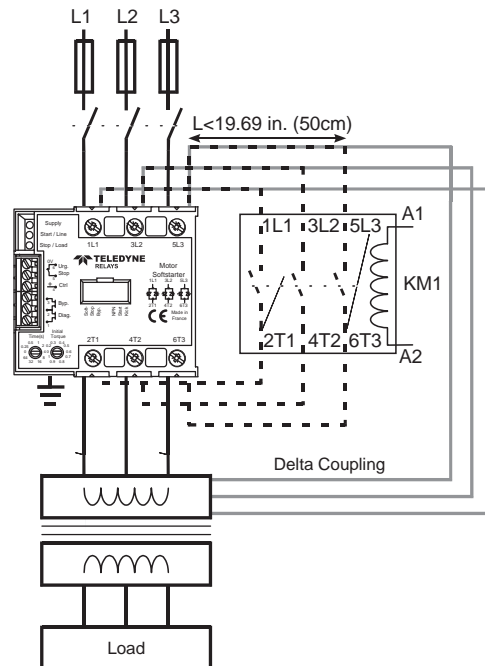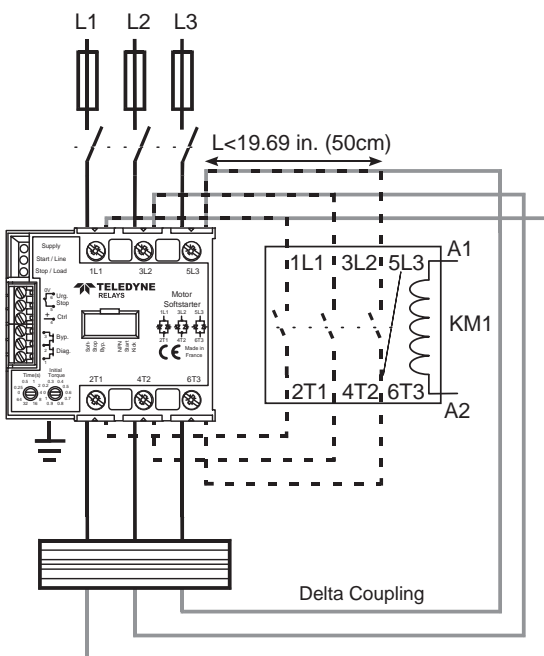**INSTALLATION**

WIRING POSSIBILITIES

Fig. 21 | **UPON THE MAINS CONTROL**
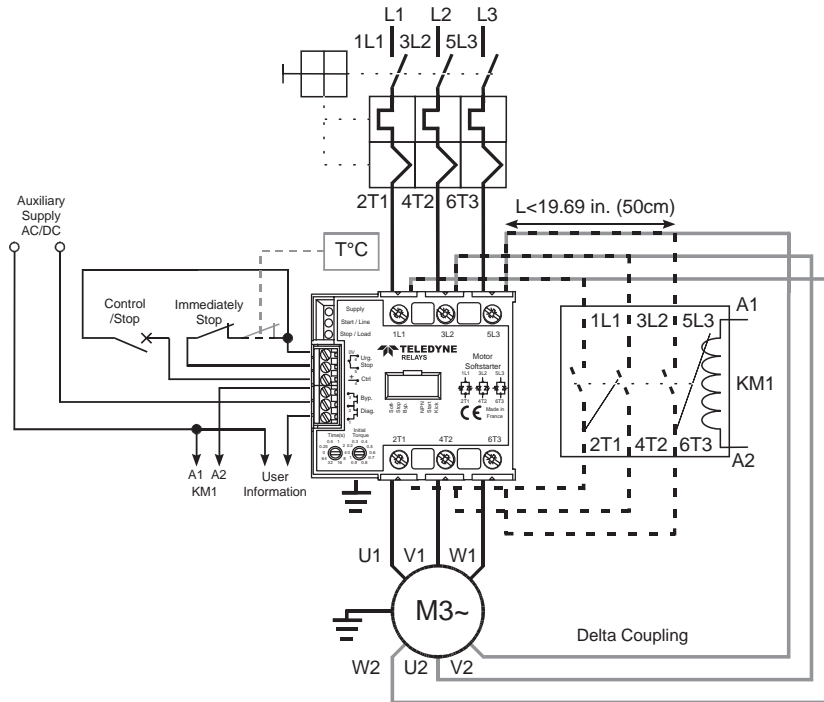
OTHER LOAD POSSIBILITIES

SOFTSTARTING INCANDESCENT OR INFRARED LAMPS (AC1 CURRENT)

SOFTSTARTING THREE-PHASE LOADED TRANSFORMERS (PLEASE CONTACT US)

INSTALLATION

MOUNTING

Fig. 22	MOUNTING PRECAUTIONS

The softstarter must be mounted vertically to ensure a good thermal convection. A minimum space must be left free around the assembly.
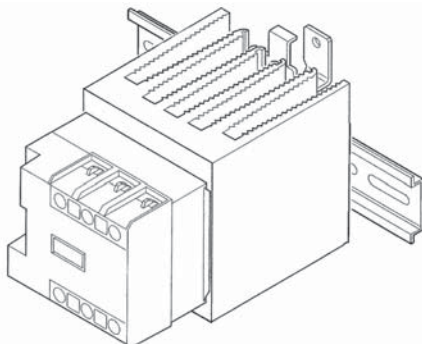
0.7874 (20) min.

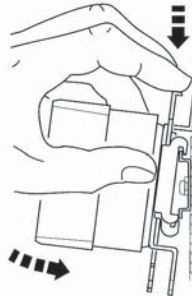0.7874 (20) min.

CAUTION!
High temperature

MOUNTING WITH SCREWS

Ø 0.2165 (5.5)

0.9843 (25)

3.937 (100)

Ø 0.2165 (5.5)
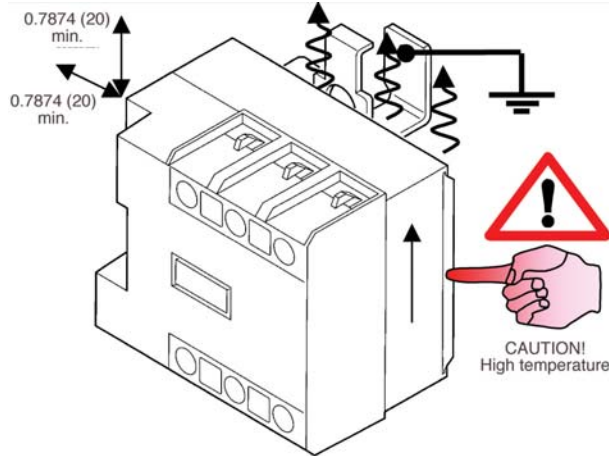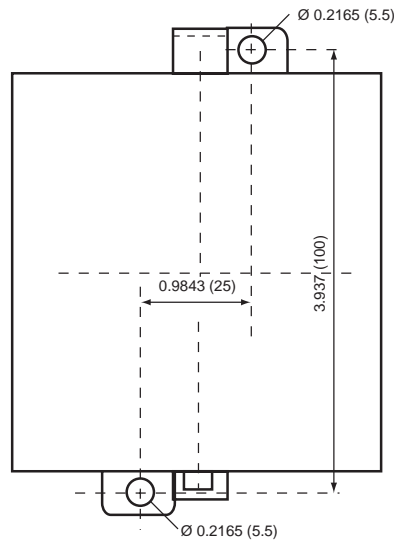
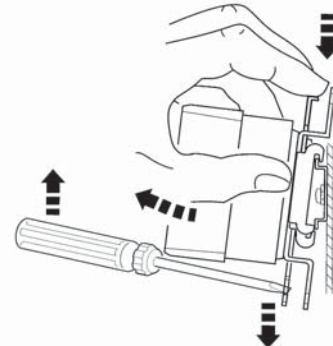### OMEGA DIN RAIL MOUNTING (EN50022)

MOUNTING	FIXING	REMOVING

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