



Single phase compressor soft starter



Description

The **SmoothStarter** is a single phase soft starter for single phase compressors up to 16 Arms (SS230V1P08-16) and 16 Arms up to 32 Arms (SS230V1P16-32).

The **SmoothStarter** can reduce inrush currents by >60% (under balanced conditions) and has a maximum ramp-up time of 600 ms. A special function (HP function) allows it to start compressors, even when pressures are not balanced, by allowing a maximum current of 60 Arms (for SS230V1P08-16 models) and 80 Arms (for models SS230V1P16-32).

Following the ramp-up, the semiconductors will be bypassed by the internal electromechanical relay. The **SmoothStarter** is rated for a maximum of 10 starts per hour (evenly distributed).

Applications

- Scroll compressors, piston compressors

Main Features

- Limitation of compressor starting current
- Ramp-up time optimised to 600 ms
- Voltage dips/interruptions detection during bypass state

Benefits

- **Easy to use.** No user adjustments required.
- **Space saving solution.** Compact DIN or panel mount versions available. Integrated start capacitor.
- **Integrated diagnostics.** Detection for voltage dips and interruptions. Detection of welded relay contacts.
- **Adjusts to load requirements.** The built-in HP function ensures that the compressor starts in <1 second even under high pressure difference during start.
- **Reduces light flicker.** SmoothStarter reduces the compressor start current by >60% to reduce light flickering.
- **Provides AC longevity.** Soft starters ensure smooth and uniform starting by torque control for gradual acceleration of the drive system.
- **Extended servicing and product replacement.** Extends the life of mechanical components and reduces their maintenance requirements.

Usage

RUN YOUR AC ON A GENERATOR, SOLAR, OR BATTERY STORAGE SYSTEM: These systems can only support so much starting wattage when it comes to starting an AC unit or other large motor load. The SmoothStarter soft starter can greatly reduce the starting wattage of an AC compressor, allowing it to start more easily.

Order Code

SS230V

Enter the code entering the corresponding option instead of .

Code	Option	Description	Notes
S	-	SmoothStarter Soft starter	
S	-	Single phase control	
230V	-	230 VAC	Rated operational voltage
<input type="checkbox"/>	1P08-16	Suitable for compressors rated from 8 to 16 A	
<input type="checkbox"/>	1P08-32	Suitable for compressors rated from 16 to 32 A	

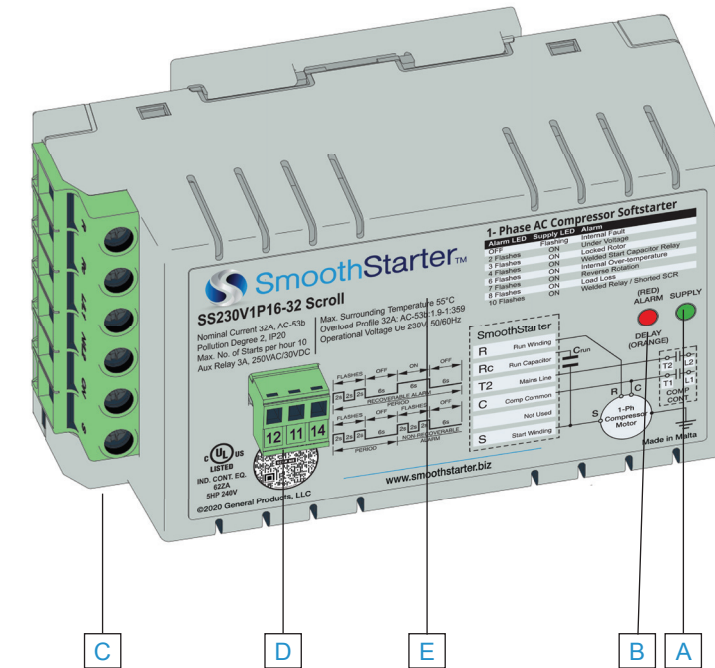


- The internal relays may be in an undefined state due to shocks during transportation. In case both relays are latched in the ON state, there will be a direct on line start of the compressor, even without a control signal.
- To avoid direct on line start, the user should do an initial power up with no load connected for a period of ≥3 seconds.
- Short circuit and overload protection are not provided with the SmoothStarter and must be installed separately.
- The SmoothStarter soft starter is not to be used as a safety device. The SmoothStarter, on its own, cannot guarantee any safety and therefore other components need to be used to ensure that the system operates safely.
- Repeated starts under unbalanced pressure (resulting in HP starts) will reduce the lifetime of the SmoothStarter.

Selection Guide

Scroll compressor size	Part number
Up to 16A	SS230V1P08-16
>16 to 32A	SS230V1P16-32

Structure



Element	Component	Function
A	LED indicators	Supply (Green). Indicates that the SmoothStarter™ supply is ON.
B	LED indicators	Alarm (Red). Indicates that the SmoothStarter is in alarm. The number of flashes indicates the alarm type.
		Recovery between starts (Orange). Indicates that the recovery time between starts has not yet elapsed. Note: During recovery between starts the SmoothStarter will not respond to control voltage.
C	Outputs	R: Connection to compressor main winding (R)
		Rc: Connection to run capacitor
		T2: Mains supply connection (Line 2)
		C: Compressor common
D	Alarm relay	S: Connection to compressor start winding (S)
		Alarm relay (Changeover) 11, 12: Normally closed (NC) 11, 14: Normally open (NO)
E	QR code	Scan to link to product website.

Mode of operation

The SmoothStarter series of soft starters is designed for single phase compressors with a maximum start time of 1 second. Typical applications include scroll and piston compressors.

Current Limit Algorithm

The SmoothStarter soft starter series works on a current limit algorithm. When mains is applied, the SmoothStarter starts the ramp-up sequence. Models SS230VIP08-16 limit the compressor starting current to 30 Arms whereas SS-230VIP16-32 limit the starting current to 45 Arms. Once the compressor reaches full speed, the SmoothStarter automatically detects this condition and switches on the bypass relay to reduce heat dissipation within the electrical panel. The SmoothStarter will optimise the motor start time to around 600 ms (See Fig. 1).

High Pressure (HP) Function

During the ramp-up sequence, the SmoothStarter will check if the motor is rotating. If the SmoothStarter finds that the motor is in locked rotor condition, it will trigger the HP function after ~ 250 ms (See Fig. 2). During the HP sequence, the SmoothStarter will gradually increase the current limit setpoint up to a maximum of 60 Arms in case of SS230VIP08-16 and 80 Arms for SS230VIP16-32 models. This mode of operation is required when the starting pressures are not balanced or where voltage supply is very weak.

Note: Starts under unbalanced pressure conditions can reduce the lifetime of the SmoothStarter due to the higher current flowing through the components. Allow enough time between starts to ensure that starting pressures difference is kept to a minimum.

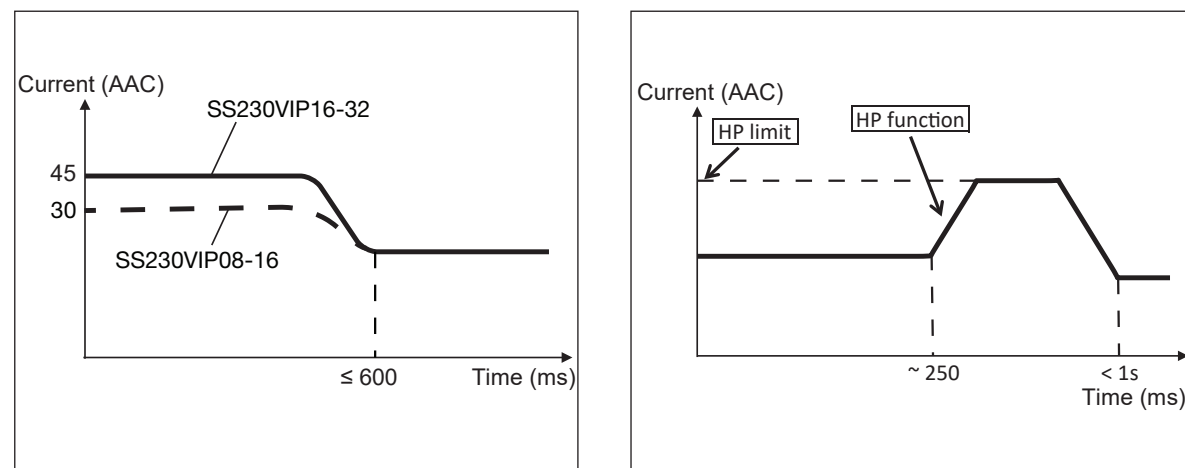


Fig. 1

Features

General Data

Material	PA66
Assembly	DIN or panel
Touch protection	IP20
Weight	Approx. 450 g
Overvoltage category	II

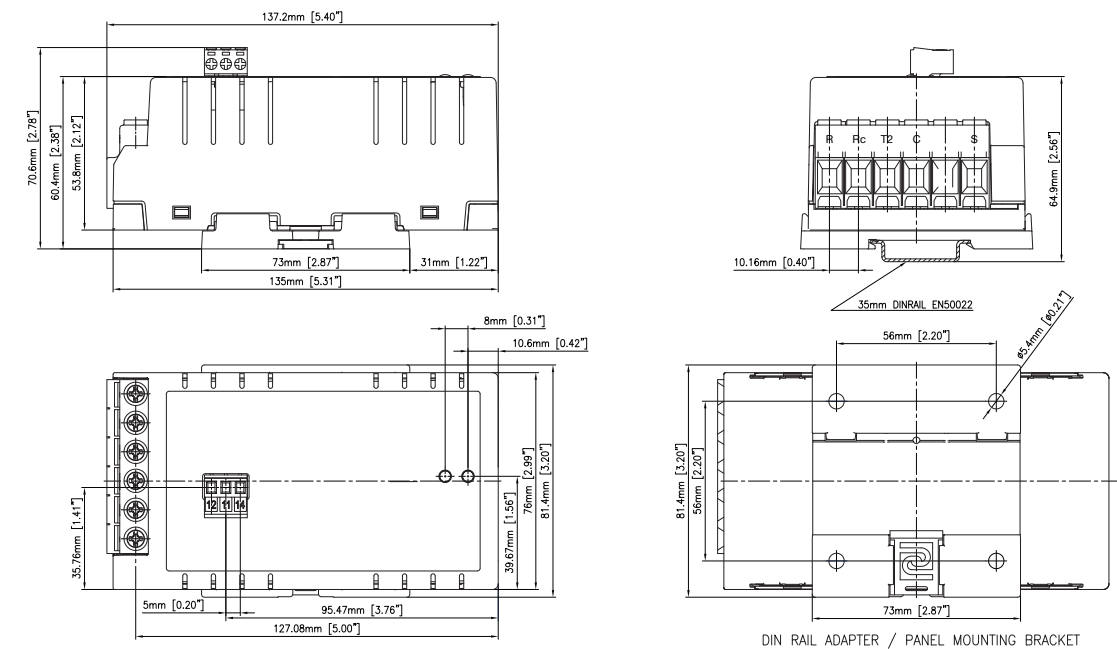


Fig. 2 SS230VIP08-16/SS230VIP16-32

Settings

Ramp-up time	≤ 600 ms
Ramp-down time	0 s


Power Supply

Operational voltage range	195.5 – 264.5 VAC
Supply current at idle	≤ 15 mA
Blocking voltage	1200 Vp
Rated AC frequency	50/60 Hz (+/- 5 Hz)
Rated insulation voltage	250 VAC
Integrated varistor	Yes
Pickup voltage	90 VAC
Drop out voltage	25 VAC

Environmental

Operating temperature	-4°F to + 131°F (-20°C to +55°C)
Storage temperature	- 22°F to +158 °F (- 30°C to + 70°C)
Relative humidity	<95% non condensing @ 104°F
Pollution degree	2
Installation category	II
Installation altitude	0 - 1000 m
Vibration resistance	2 g / axis (2 - 100 Hz, IEC60068-2-6, EN50155, EN61373)
Impact resistance	15/11 g/ms (EN50155, EN61373)
EU RoHS compliant	Yes

Compatibility and conformity

Conformance	IEC/EN 60947-4-2, UL60947-4-2
Approvals	

Electromagnetic compatibility (EMC) - immunity	
Electrostatic discharge (ESD)	EN/IEC 61000-4-2 8 kV air discharge, 4 kV contact (PC2)
Radiated radio frequency	EN/IEC 61000-4-3 3 V/m, from 80 MHz to 1 GHz (PC1) 3 V/m, from 2 to 2.7 GHz (PC1)
Electrical Fast Transient (Burst)	EN/IEC 61000-4-4 Output: 2 kV, 5 kHz (PC2) Input: 1 kV, 5 kHz (PC2)
Conducted Radio Frequency	EN/IEC 61000-4-6 3 V/m, from 0.15 to 80 MHz (PC1)
Electrical Surge	EN/IEC 61000-4-5 Output, line to line: 1 kV (PC2) Output, line to earth: 2 kV (PC2) Input, line to line: 0.5 kV (PC2) Input, line to earth: 1 kV (PC2)
Voltage dips and interruptions	EN/IEC 61000-4-11

Electromagnetic compatibility (EMC) - emissions	
Radio interference field emissions (conducted)	CISPR 11, EN/IEC 55011 Class B ¹
Harmonics	IEC/EN 61000-3-2 ¹ IEC/EN 61000-3-12 ¹
Disturbance power	CISPR 14, IEC/EN 55014-1 ¹
Flicker	IEC/EN 61000-3-11 ¹ (load conditions apply)

1. Applicable when current limit is $\leq 45 A_{rms}$

Note:

- Performance Criteria 1 (PC1): No degradation of performance or loss of function is allowed when the product is operated as intended.
- Performance Criteria 2 (PC2): During the test, degradation of performance or partial loss of function is allowed. However when the test is complete the product should return operating as intended by itself.
- Performance Criteria 3 (PC3): Temporary loss of function is allowed, provided the function can be restored by manual operation of the controls.

Inputs

Control voltage (U _c)	230 VAC ($\pm 15\%$)
Control voltage range (U _c)	195.5 – 264.5 VAC
Maximum pick-up voltage	90 VAC
Minimum drop out voltage	25 VAC
Rated AC frequency	50 / 60 Hz (± 5 Hz)
Rated insulation voltage (U _i)	250 VAC
Control input current	3 mA _{rms} – 6 mA _{rms}

Outputs

	SS230V1P08-16	SS230V1P16-32
Overload cycle @ 104°F surrounding temperature (acc. to IEC/EN 60947-4-2)	AC53b: 1.9 - 1 : 359	
Maximum number of starts/hr @ rated overload cycle @ 104°F surrounding temperature	10 (evenly distributed)	
Rated operational current @ 104°F	32 Arms	
Current limit	30 Arms	45 Arms
Maximum starting current	60 Arms	80 Arms
Minimum load current	2.5 Arms	
Minimum time between starts	6 minutes (suggested)	
Minimum time between stop to start	3 minutes (suggested)	

Auxiliary Relays

Number of output relay	1
Function of relay	Alarm
Rated operational voltage	250 VAC / 30 VDC
Rated insulation voltage	250 VAC
Dielectric withstand voltage	2.5 kV
Overvoltage category	II
Type of control circuit	Electromechanical relay
Number of contacts	2
Type of contacts	Changeover: Normally closed (NC), Normally open (NO)
Type of current	AC / DC
Rated operational current	3 Arms @ 250 VAC, 3 Arms @ 30 VDC

Performance

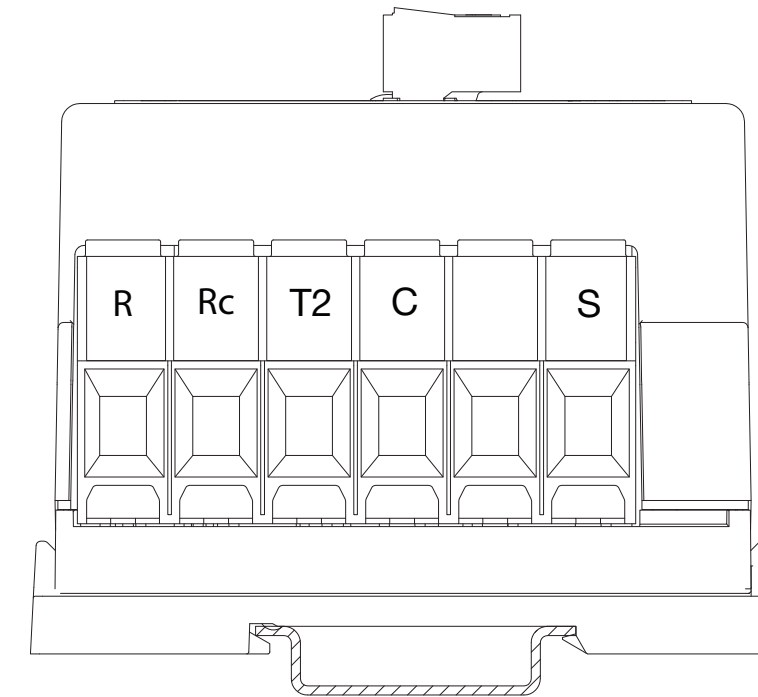
Current / Power Ratings: kW and HP @ 104°F

Model	IEC rated current	SS230V1P08-16/SS230V1P16-32
SmoothStarter™	32 Arms	4.4 kW / 5 HP

Ratings:
kW rating according to IEC/EN 60947-4-2

Connection Diagrams

Terminal Markings



SS230V1P08-16/SS230V1P16-32

Marking	
R	Connection to compressor main winding (R)
Rc	Connection to run capacitor
T2	Mains supply connection
C	Compressor common
S	Connection to compressor start winding (S)

Wiring Diagrams

No START CAP / Split RUN CAP – Fan Circuit Included
 DISCONNECT ALL SUPPLY VOLTAGES BEFORE WORKING ON ANY EQUIPMENT.

Fig. 1 Conventional HVAC unit with a contactor installed.

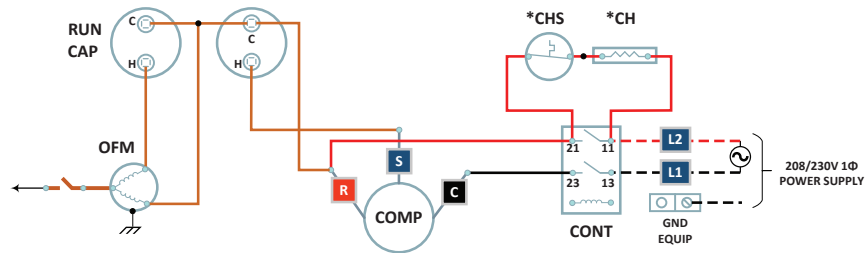
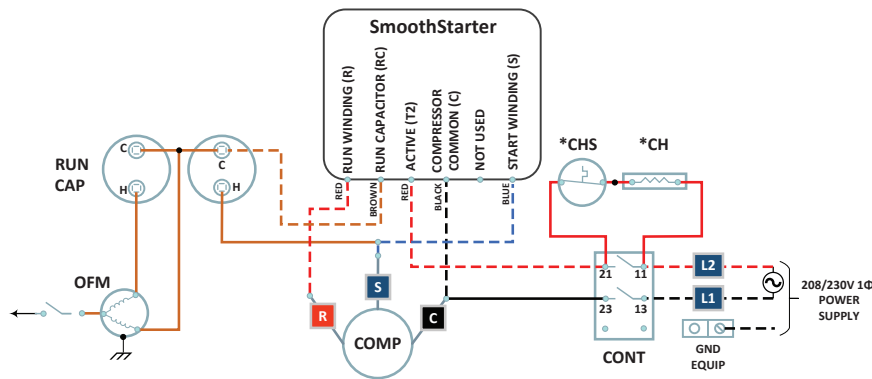


Fig. 2 Installing SmoothStarter



No START CAP / Split RUN CAP – Fan Circuit Not Included
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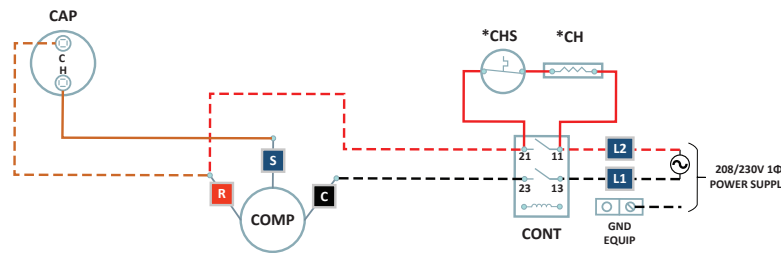
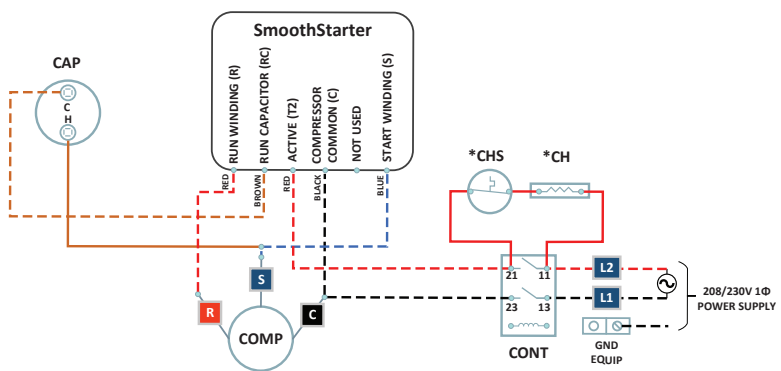


Fig. 2 Installing SmoothStarter



START CAP / Dual RUN CAP – Fan Circuit Included
 DISCONNECT ALL SUPPLY VOLTAGES BEFORE WORKING ON ANY EQUIPMENT.

Fig. 1 Conventional HVAC unit with hard start kit installed.

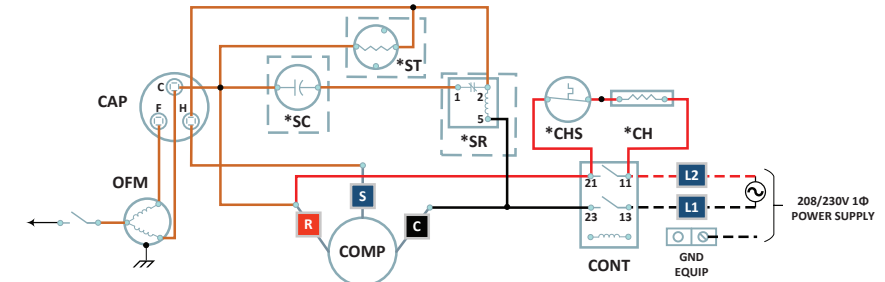
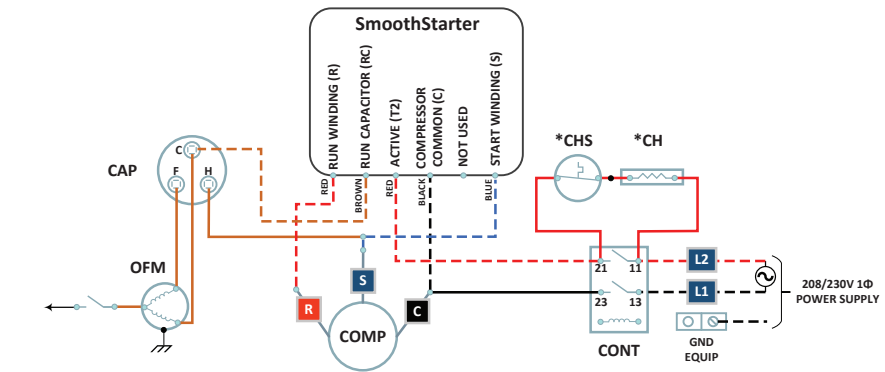


Fig. 2 Installing SmoothStarter



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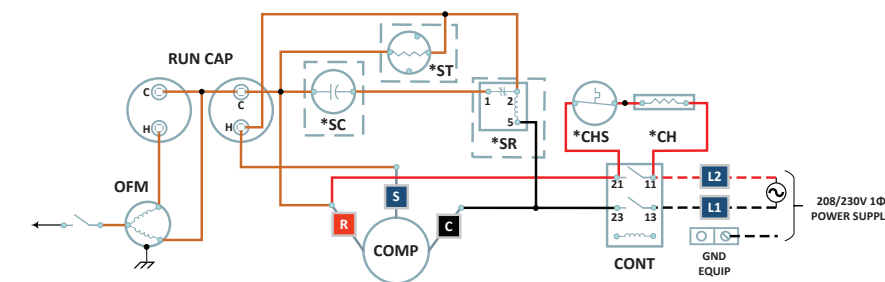
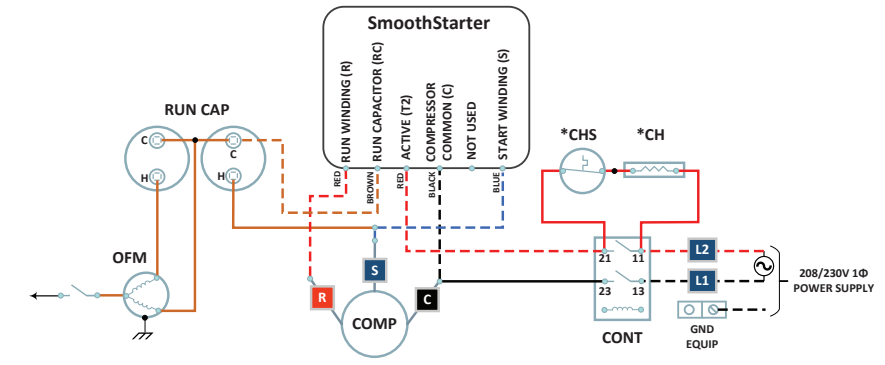


Fig. 2 Installing SmoothStarter



START CAP/SPLIT RUN CAP - Fan Circuit Not Included
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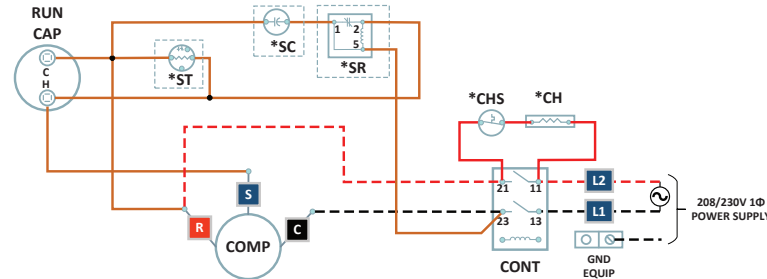
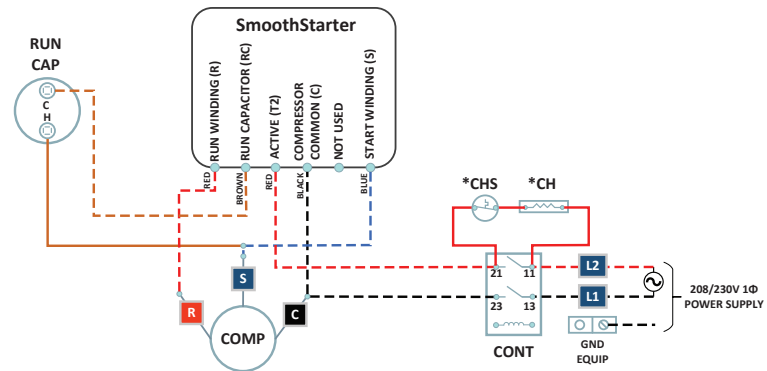


Fig. 2 Installing SmoothStarter



- LEGEND -

- ☒ Factory Power Wiring
- ☒ Field Power Wiring
- ☒ Component Connection
- Junction
- CAP Capacitor(Dual Run)
- *CH Crankcase Heater
- *CHS Crankcase Heater Switch
- COMP Compressor
- CONT Contactor
- OFM Outdoor Fan Motor
- C Common
- H Compressor
- F Fan

Note: "H" Stands for Hermetic which is a type of compressor

*May be factory or field installed

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Fig. 1 Conventional HVAC unit with hard start kit installed.

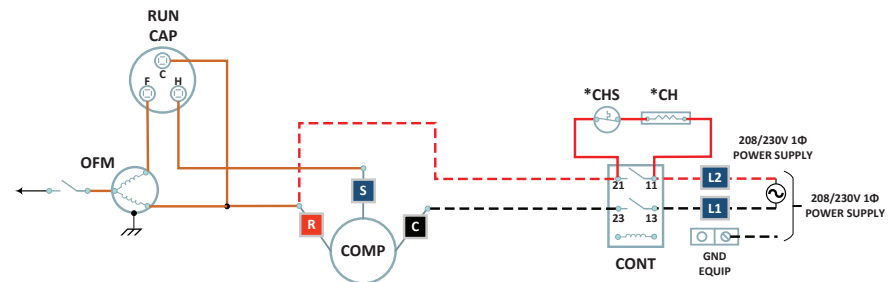
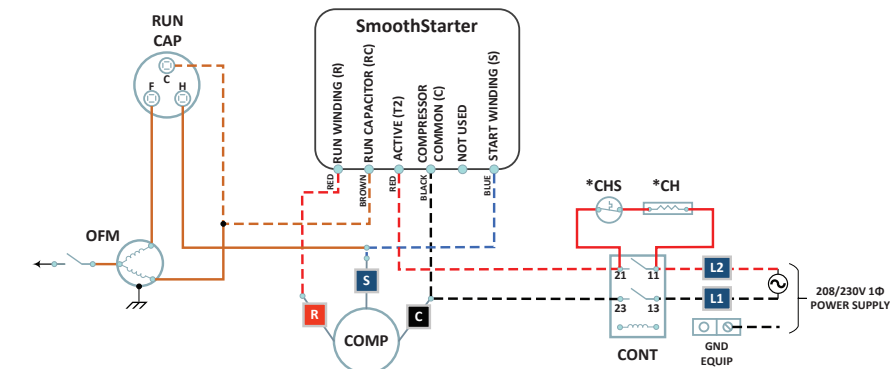


Fig. 2 Installing SmoothStarter



Connection Specifications

Main conductors (R, Rc, T2, C, S)	
Flexible (solid or stranded)	0.5 – 16 mm ² , AWG 20 - 6
Terminal screws	M4
Maximum tightening torque	1.19 Nm (10.5 lb-in)
Stripping length	8.0 mm

Auxiliary conductors (11, 12, 14)	
Flexible (solid or stranded)	0.2 – 1.5 mm ² , AWG 30 - 12
Terminal screws	M3
Maximum tightening torque	0.5 Nm (4.5 lb-in)
Stripping length	7.0 mm - 8.0 mm

Note: Use 75°C Copper (Cu) conductors

Troubleshooting

LED and Relay Status Indications

State	Supply (Green LED)	Delay (Orange LED)	Alarm (Red LED)	Relay contact position (12, 11, 14)
Idle	ON	OFF	OFF	11, 12
Ramping	ON	OFF	OFF	11, 12
Bypass	ON	OFF	OFF	11, 12
Alarm	ON	OFF	Flashing	11, 14
Alarm recovery	ON	OFF	Flashing	11, 14
Internal power supply fault	Flashing	OFF	OFF	11, 12

Alarms

The SmoothStarter includes a number of diagnostics and protection features each of which is signalled through a flashing sequence on the red LED.

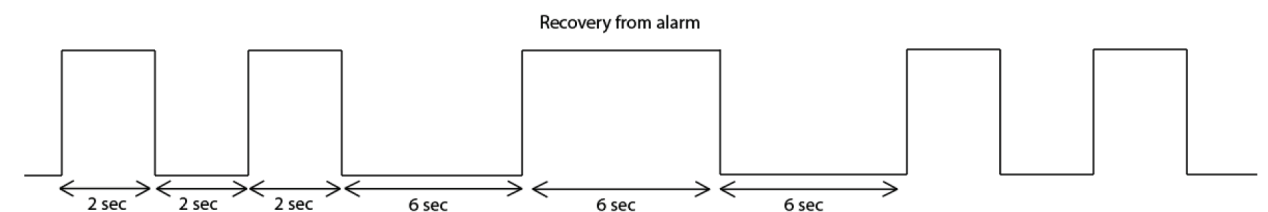
Note: In case there is a fault in the internal power supply (PSU) of the SmoothStarter, the green LED (and not the red LED) will start flashing. In this condition, the relay contact will not change state.

Flashing Sequence

Every alarm that the SmoothStarter™ will trigger will be signalled via a specific flashing sequence on the red LED. The specific alarm will flash with a period of 2 s ON, 2 s OFF.

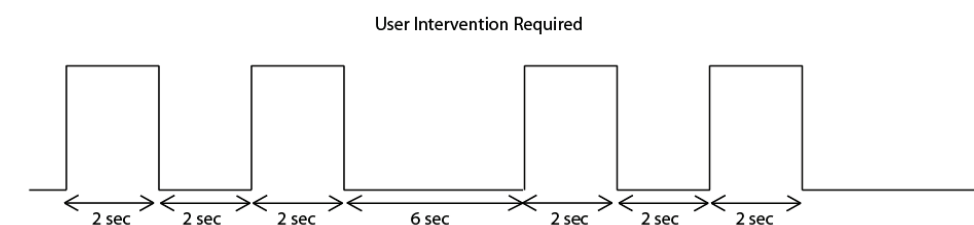
Flashing sequence during recovery from alarm

When the alarm can self-recover, the flashing sequence of the red LED will be interleaved with a 6 s ON-OFF-ON flashing sequence and then the flashing sequence will repeat (see diagram below).



Flashing sequence when user intervention is required

In the case where user intervention is required to perform a hard reset, the flashing sequence of the alarm will be followed by a 6 s OFF period followed by the flashing sequence. This flashing sequence will repeat itself until a hard reset is performed.



Number of flashes	2
Alarm	Under voltage ³
Alarm description	The under voltage alarm will be triggered when the supply voltage (Ue) is:- Condition 1: Ue < 190 VAC for ≥ 1 s Condition 2: 140 VAC < Ue < 160 VAC for ≥ 200 ms Condition 3: 90 VAC < Ue < 140 VAC for ≥ 100 ms Condition 4: Ue = 0 VAC for > 50 ms (+20 ms)
Alarm recovery period	5 mins (from the moment when voltage is within operational range)
Consecutive alarms for hard reset	N/A
Action to recover alarm	The alarm will self-recover after the recovery period. Voltage dips/interruptions during recovery between starts and/or alarm recovery shall be ignored.
Troubleshooting	<ul style="list-style-type: none"> • Check for any loose connections on T2 and C terminals. • Check quality and level of supply voltage after compressor starts.

3. The under-voltage alarm is only active in bypass state

Number of flashes	3
Alarm	Locked rotor
Alarm description	The locked rotor alarm will be triggered when the measured current (in bypass state) exceeds 32 AAC. The alarm trigger time will vary according to the chart below.
Alarm recovery period	5 minutes
Consecutive alarms for hard reset	4
Action to recover alarm	The alarm will self-recover after the recovery period. If this alarm is triggered on 4 consecutive starts, user intervention will be required to reset the power supply (L/L1 & L2/N).
Troubleshooting	<ul style="list-style-type: none"> • Check compressor windings resistance to check if motor is damaged. • Check for any blockage in the system.

Measured current (Arms)	Time to trip (s)
33.6	1
35.2	0.5
38.4	0.2
41.6	0.1
≥ 44.8	0.05

Number of flashes	4
Alarm	Start capacitor relay protection
Alarm description	This alarm will be triggered when the SmoothStarter™ detects a faulty start capacitor electro-mechanical relay (EMR).
Alarm recovery period	5 minutes
Consecutive alarms for hard reset	2
Action to recover alarm	The alarm will self-recover after the recovery period. Before attempting a second start, the SmoothStarter will check the status of the EMR. If the EMR is found to be still faulty, the SmoothStarter will remain in the alarm state. User shall then reset the mains supply to reset the SmoothStarter.
Troubleshooting	<ul style="list-style-type: none"> • Check that the proper SmoothStarter™ model (start capacitor size) is being used. • Check for proper wiring.

Number of flashes	6
Alarm	Internal over-temperature alarm
Alarm description	The SmoothStarter™ will trigger this alarm if it measures an internal temperature > 239°F for ≥ 1s
Alarm recovery period	Typically 5 mins – SmoothStarter™ might need a longer recovery period depending on the surrounding temperature level.
Consecutive alarms for hard reset	4
Action to recover alarm	The alarm will self-recover after the recovery period.
Troubleshooting	<ul style="list-style-type: none"> • Check that there is proper ventilation around SmoothStarter™. • Ensure that the vents of SmoothStarter™ are not obstructed.

Number of flashes	7
Alarm	Compressor running in reverse
Alarm description	The SmoothStarter™ shall detect that the compressor is rotating in the reverse direction within 2 seconds. The alarm is active in bypass state only.
Alarm recovery period	5 minutes
Consecutive alarms for hard reset	4
Action to recover alarm	The alarm will self-recover after the recovery period.
Troubleshooting	<ul style="list-style-type: none"> • Check for unstable or low supply voltage level.

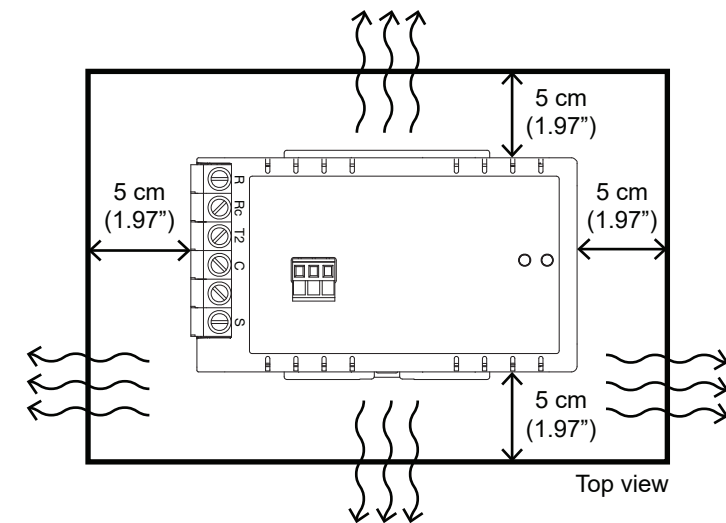
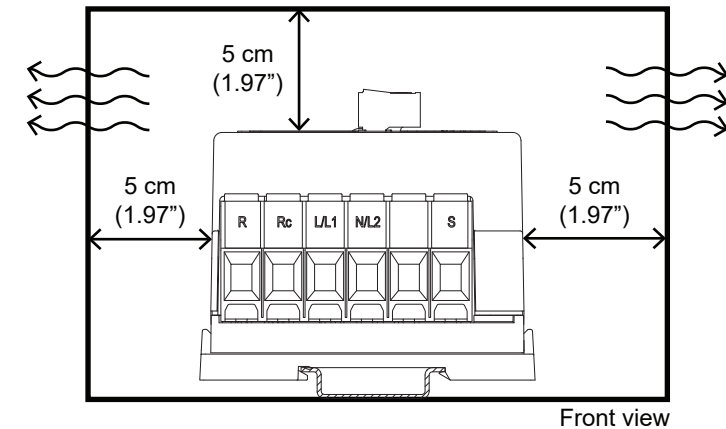
Number of flashes	8
Alarm	Load loss
Alarm description	This alarm will be triggered when the load current is ≤ 2 AAC for ≥ 1 mains cycle. The alarm will be active during ramp-up and bypass mode. Ramp-up: As soon as the ON signal is turned ON, the SmoothStarter will start the ramp-up function. If the measured current is ≤ 2 AAC then the SmoothStarter will not attempt a start and will raise the load loss alarm. Bypass: If during bypass the measured current is ≤ 2 AAC for ≥ 1 mains cycle, the SmoothStarter will trigger the load loss alarm.
Alarm recovery period	5 minutes
Consecutive alarms for hard reset	N/A
Action to recover alarm	The alarm will self-recover after the recovery period. Load current will not be monitored during recovery from alarm. If, during transition from alarm recovery to start of ramp-up, the measured current is ≤ 2 AAC ≥ 1 mains cycle the SmoothStarter will re-trigger the alarm. The alarm will self-recover after 5 minutes.
Troubleshooting	<ul style="list-style-type: none"> • Check that the compressor (or a load > 2 Arms) is connected to the SmoothStarter. • Check quality of supply. This alarm may also be triggered when there is complete supply voltage interruption.

Number of flashes	10
Alarm	Welded main relay, Shorted SCR, Welded bypass relay
Alarm description	This alarm will be triggered when :- 1. The SmoothStarter™ detects a current on the "T2" connection when it is in IDLE state. (Fault: Welded main relay). In this case the SmoothStarter™ will trigger the alarm after 100 ms. 2. The SmoothStarter™ detects a current $> I_{max}$ HP during ramp-up state (Fault: SCR short or bypass relay welded). The SmoothStarter™ will trigger the alarm after ≈ 100 ms.
Alarm recovery period	Non-recoverable alarm
Consecutive alarms for hard reset	1
Action to recover alarm	The alarm will not self-recover. In case of a main relay weld condition the user needs to provide an external means to disengage the compressor from the mains. (Since the auxiliary winding will remain connected to T2 and C through the main relay and run capacitor).
Troubleshooting	<ul style="list-style-type: none"> • Replace SmoothStarter and contact your local representative. • Check compressor winding resistance and verify that this is within manufacturer specifications.

Number of flashes	Fully ON
Alarm	Critical over-temperature alarm
Alarm description	The SmoothStarter will trigger this alarm if it measures an internal temperature $> 266^\circ\text{F}$ for ≥ 100 ms
Alarm recovery period	Alarm does not self-recover
Consecutive alarms for hard reset	1
Action to recover alarm	This alarm is considered to be a critical condition and the SmoothStarter will immediately switch OFF its output. The alarm is non-resettable. Once this alarm is triggered the user needs to replace the SmoothStarter.
Troubleshooting	<ul style="list-style-type: none"> • Check that there is proper ventilation around SmoothStarter. • Replace the SmoothStarter with a new one.

Installation

Provide sufficient air circulation space for cooling as shown in the examples below. Do not obstruct the SmoothStarter vents.



Short Circuit Protection

Type 1 protection implies that after a short circuit, the device under test will no longer be in a functioning state. The product variants listed in the table hereunder are suitable for use on a circuit capable of delivering not more than 5,000 symmetrical Amperes, 240 Volts maximum when protected by fuses. Tests at 5,000 A were performed with Class RK5 fuses; please refer to the table below for maximum allowed Ampere rating of the fuse. Use fuses only.

Protection Coordination Type 1 According to UL 60947-4-2

Part No.	Prospective short circuit current [kArms]	Max fuse size [A]	Class	Article no.
SS230V1P08-16 SS230V1P16-32	5	45	RK5	FLSR45 (manufacturer: Littlefuse)



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