RSBS

1-phase compressor soft starter

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.
- **Guided model selection.** Easy to use online selection tool to select the appropriate soft starter model depending on the compressor brand/model. http://gavazziautomation.com/nsc/HQ/EN/soft_starters.
- **Reduces light flicker.** RSBS reduces the compressor start current by >50% to reduce light flickering.

Description

The **RSBS....V23C..** is a single phase soft starter for 1 phase compressors up to 32 Arms.

The **RSBS** can limit inrush currents to 45 AACrms (under balanced conditions) and has a maximum ramp-up time of 600 ms. A special function (HP function) allows the **RSBS** to start compressors, even when pressures are not balanced, by allowing a maximum current of 80 AACrms. Following the ramp-up, the semiconductors will be bypassed by the internal electromechanical relay. The **RSBS** 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
- Anti-short cycling function with built-in delay between starts
- Voltage dips/interruptions detection during bypass state

Order code

RSBS 23 32 A2 V23 ☐ HP

Enter the code entering the corresponding option instead of ☐.

Code	Option	Description	Notes
R	-	Soft starter	
S	-		
B	-	Compressor soft starter	
S	-	Single phase control	
23	-	230 VAC	Rated operational voltage
32	-	32 Arms	Rated operational current
A2	-	230 VAC	Rated control voltage
V	-	Options	
2	-	Auxiliary relay output	Alarm status indication
3	-	Third generation	
☐	C24	Internal start capacitor: 200 – 240 µF	
	C17	Internal start capacitor: 145 – 175 µF	
	C10	Internal start capacitor: 100 – 140 µF	
	C00	External start capacitor	
HP	-	Control algorithm for high pressure starts	See caution notes

- 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 RSBS and must be installed separately.
- The RSBS soft starter is not to be used as a safety device. The RSBS, 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 RSBS.

Selection guide

Start capacitor size	Part number
200 – 240 µF	RSBS2332A2V23C24HP
100 – 140 µF	RSBS2332A2V23C10HP
145 – 175 µF	RSBS2332A2V23C17HP
External	RSBS2332A2V23C00HP

For proper model selection refer to our online soft starter selector tool:
http://www.gavazziautomation.com/nsc/HQ/EN/soft_starters

Selection guide

Category	Compressor maximum operating current (I_{MAX})	Model selection
Compressors	2.5 - 16 Arms	RSBS2332A2V23C10HP
	16 - 32 Arms	RSBS2332A2V23C24HP
Note: For compressors with I_{MAX} ≥ 25 Arms that start with unequalised pressures (> 5 bar) the model RSBS2332A2V23C00HP is recommended.		

Further reading

Information	Where to find it	
RSBS instruction manual	http://cga.pub/?a1f658	
Troubleshooting guide	http://cga.pub/?686d1f	
CAD drawings	3D (.dwg) - http://cga.pub/?ada314	
	2D (.dwg) - http://cga.pub/?e0d224	
	Step (.stp) - http://cga.pub/?f889f6	

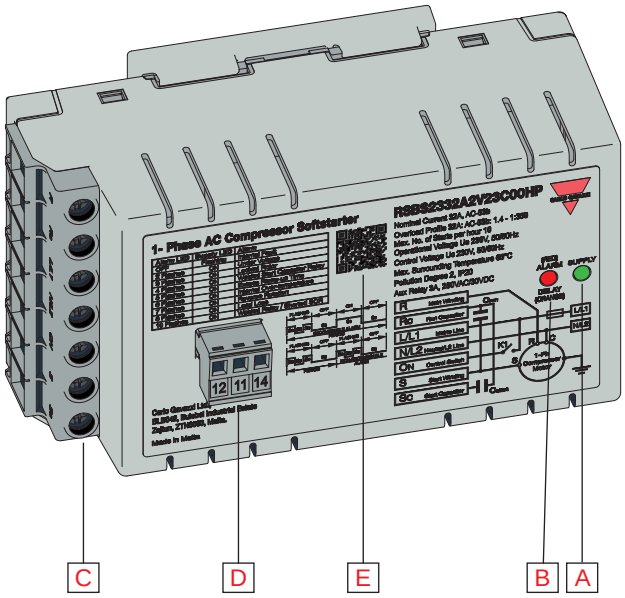
CARLO GAVAZZI compatible components

Purpose	Component name/code	Notes
External start capacitor kit	STARTCAP-200UF-SMA	For RSBS2332A2V23C00HP models

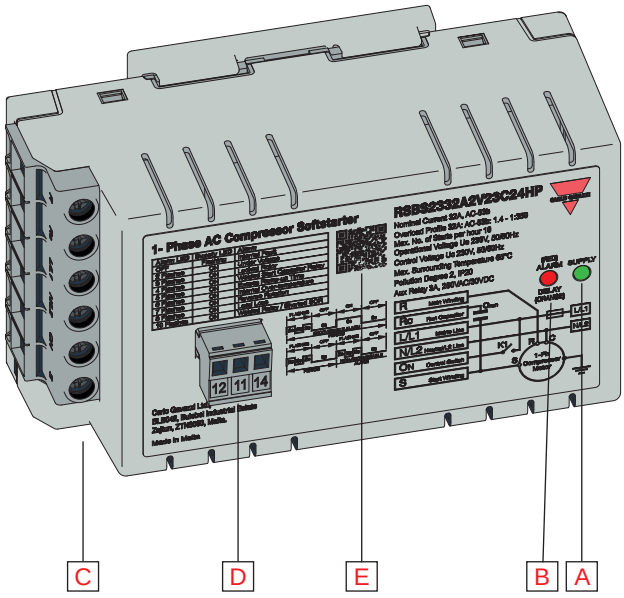
Note: Use a start capacitor with rated voltage of 330 VAC or higher. Start capacitor must also have a 15kΩ (2W) bleed resistor.

Structure

RSBS2332A2V23C00HP



RSBS2332A2V23C..HP



Element	Component	Function
A	LED indicators	Supply (Green). Indicates that the RSBS supply is ON.
B	LED indicators	Alarm (Red). Indicates that the RSBS 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 RSBS will not respond to control voltage.
C	Outputs	R: Connection to compressor main winding (R)
		Rc: Connection to run capacitor
		L / L1: Mains supply connection
		N / L2: Supply neutral connection (L2 connection for U.S. applications)
		ON: Control input signal (start signal)
		S: Connection to compressor start winding (S)
		Sc: Connection to external start capacitor (only for C00 versions)
D	Alarm relay	Alarm relay (Changeover) 11, 12: Normally closed (NC) 11, 14: Normally open (NO)
E	QR code	Scan to link to troubleshooting guide.

Mode of operation

The RSBS 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 RSBS soft starter series works on a current limit algorithm. When control signal is applied via the On terminal, the RSBS start the ramp-up sequence. The compressor start current is limited to 45 Arms. Once the compressor reaches full speed, the RSBS automatically detects this condition and switches on the bypass relay to reduce heat dissipation within the electrical panel. The RSBS will optimise the motor start time to around 600 ms (See Fig. 1).

If the motor does not reach full speed within a maximum of 1 second, the RSBS will trigger the excess ramp-up time alarm (5 flashes) to protect the internal relay from switching a too high current that would reduce the relay lifetime. The alarm will self-recover after 5 minutes.

High pressure (HP) function

During the ramp-up sequence, the RSBS will check if the motor is rotating. If the RSBS 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 RSBS will gradually increase the current limit setpoint up to a maximum of 80 Arms. 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 RSBS 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.

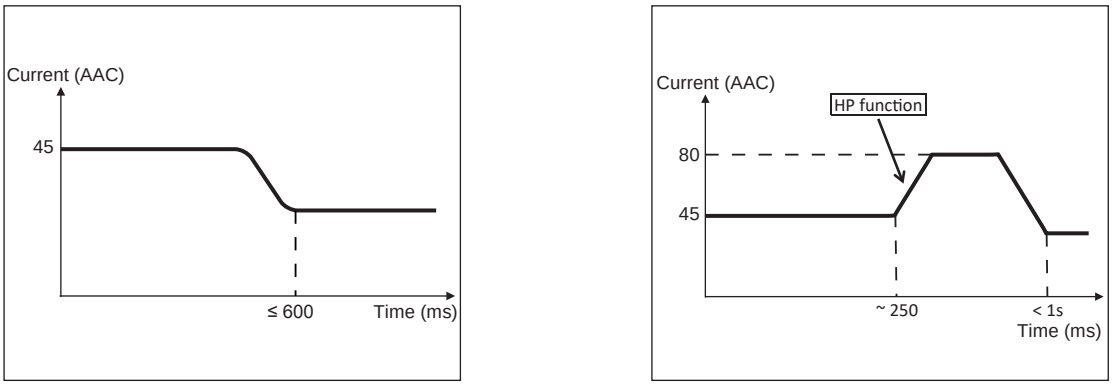


Fig. 1

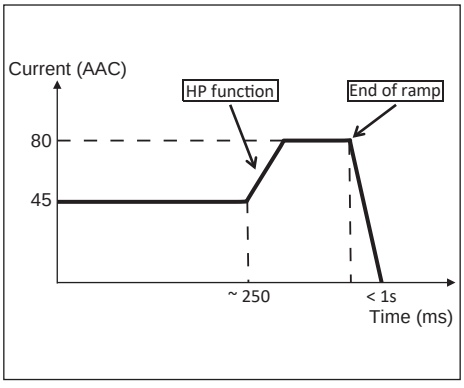


Fig. 2

Features

General data

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

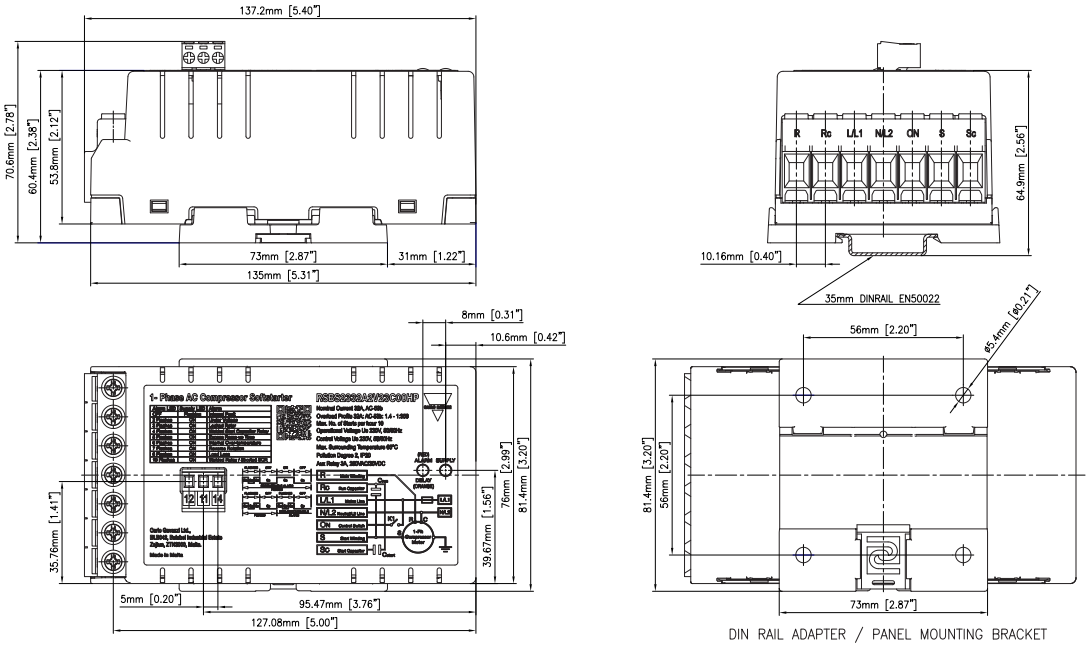


Fig. 3 *RSBS2332A2V23C00HP*

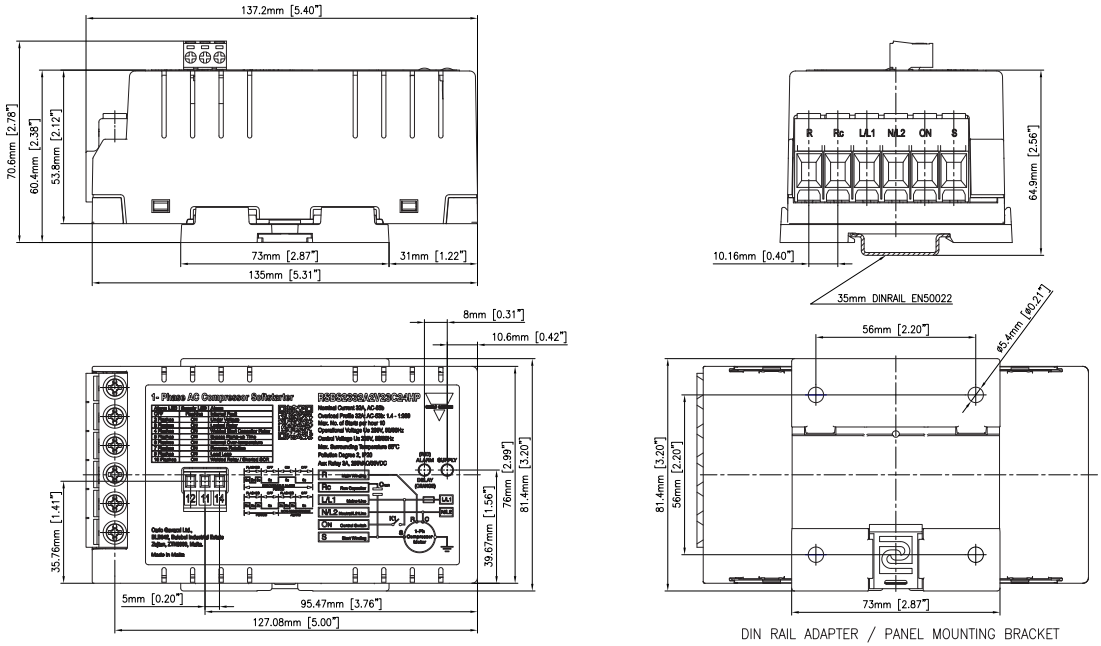


Fig. 4 *RSBS2332A2V23C..HP*

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	RSBS2332A2V23C00HP: -20ºC to +65ºC (-4ºF to +149ºF)
	RSBS2332A2V23C..HP: -20ºC to +55ºC (-4ºF to + 131ºF)
Storage temperature	- 30˚C to + 70˚C (- 22˚F to +158 ˚F)
Relative humidity	<95% non condensing @ 40ºC
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 ≤ 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 (Uc)	230 VAC (± 15%)
Control voltage range (Uc)	195.5 – 264.5 VAC
Maximum pick-up voltage	195.5 VAC
Minimum drop out voltage	25 VAC
Rated AC frequency	50 / 60 Hz (± 5 Hz)
Rated insulation voltage (Ui)	250 VAC
Control input current	3 mA_{rms} – 6 mA_{rms}

Outputs

Overload cycle @ 40ºC surrounding temperature (acc. to IEC/EN 60947-4-2)	AC53b: 1.9 - 1 : 359
Maximum number of starts/hr @ rated overload cycle @ 40ºC surrounding temperature	10 (evenly distributed)
Rated operational current @ 40°C	32 Arms
Current limit	45 Arms
Maximum starting current	80 Arms
Minimum load current	2.5 Arms
Minimum time between starts	6 minutes
Minimum time between stop to start	3 minutes

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

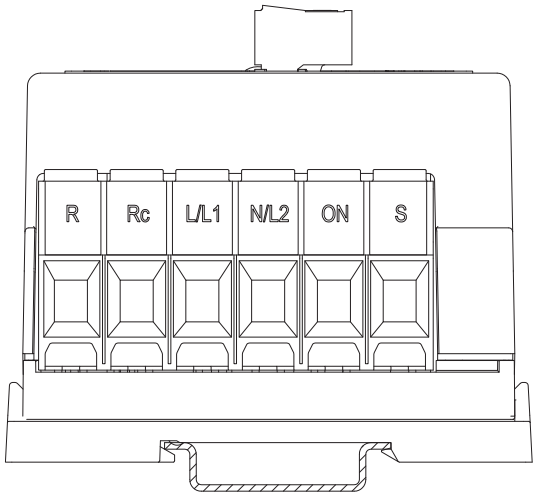
Current / power ratings: kW and HP @ 40°C

Model	IEC rated current	RSBS2332A2V23Cxx
RSBS	32 Arms	4.4 kW / 5 HP

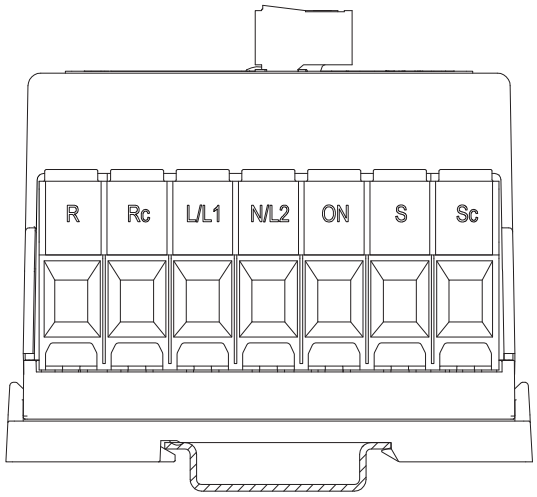
Ratings:
kW rating according to IEC/EN 60947-4-2

Connection Diagrams

Terminal markings



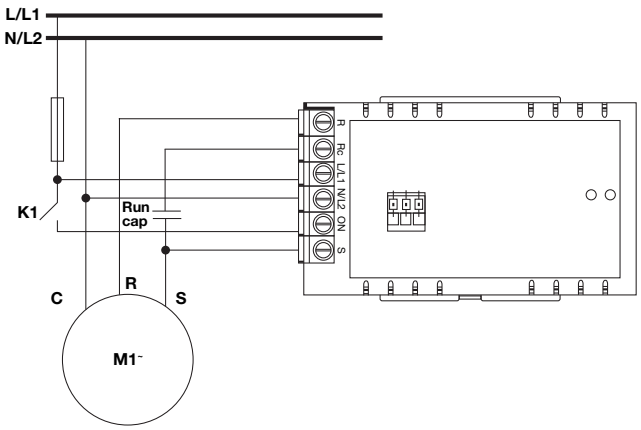
RSBS2332A2V23C..HP



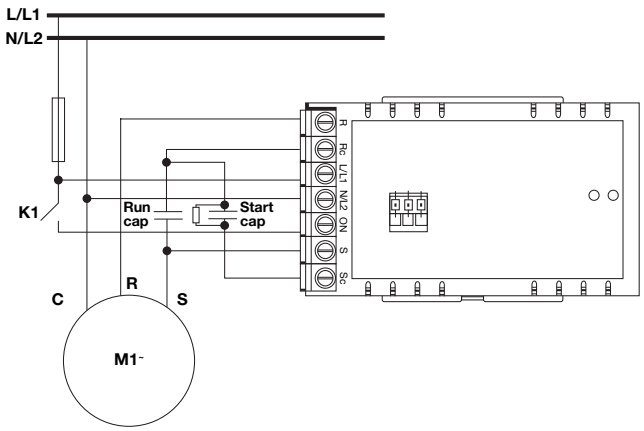
RSBS2332A2V23C00HP

Marking	
R	Connection to compressor main winding (R)
Rc	Connection to run capacitor
L / L1	Mains supply connection
N / L2	Supply neutral connection (L2 connection for U.S. applications)
On	Control input signal (start signal)
S	Connection to compressor start winding (S)
Sc	Connection to external start capacitor

Wiring Diagrams



Wiring diagram - RSBS..V23C..HP



Wiring diagram - RSBS..V23C00HP

Note: Install a 15 kΩ (2W) resistor in parallel to the start capacitor in case of RSBS..C00HP.

Connection Specifications

Main conductors (R, Rc, L /L1, N / L2, ON, S, Sc)	
Flexible (solid or stranded)	0.5 – 16 mm², 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 mm², 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 75ºC 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
Recovery time[2] (between starts)	ON	ON	OFF	11, 12
Internal power supply fault	Flashing	OFF	OFF	11, 12

2. If supply on RSBS is removed before the recovery period (6 mins) has elapsed, when supply is restored, the remaining delay will continue until the remaining recovery time (before supply removal) is over.

Alarms

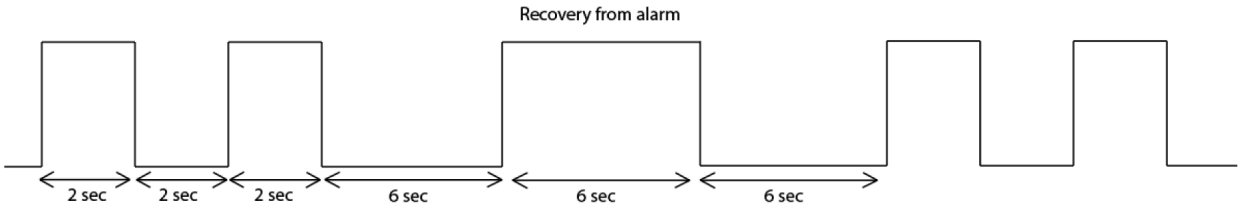
The RSBS includes a number of diagnostics and protection features each of which is signalled through a flashing sequence on the red LED.

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

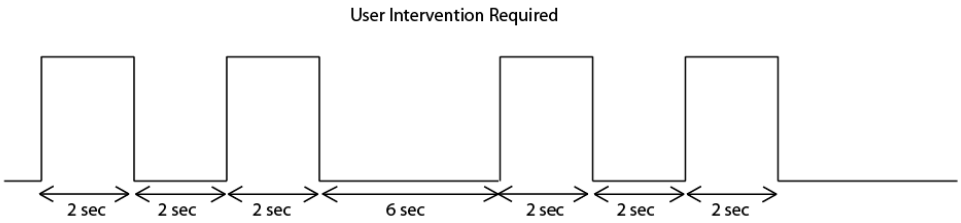
Flashing sequence

Every alarm that the RSBS 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	• Check for any loose connections on L / L1 and N / L2 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	• 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 RSBS 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 RSBS will check the status of the EMR. If the EMR is found to be still faulty, the RSBS will remain in the alarm state. User shall then reset the mains supply to reset the RSBS.
Troubleshooting	• Check that the proper RSBS model (start capacitor size) is being used. • Check for proper wiring.

Number of flashes	5
Alarm	End of ramp (EOR)
Alarm description	The RSBS will trigger this alarm if it cannot start the compressor within a maximum of 1 second. The EOR alarm will be triggered if, after the initial current limit and the subsequent HP phase (during ramp-up) the compressor does not reach nominal speed within a maximum of 1 second. The EOR alarm will prevent the RSBS from switching a high transitional current. Note: The EOR alarm may also be triggered if there is a damaged run and/or start capacitor. This results in less starting torque and therefore the compressor might not start.
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 during the second consecutive attempt, the same alarm is triggered, the RSBS will remain in the alarm state. User shall then reset the mains supply to reset the RSBS.
Troubleshooting	• Check that the proper RSBS model is being used. • Check for high pressure difference during compressor start. • If pressure difference is too high, allow more time between starts. • For the models RSBS…C00 check the value of the run and start capacitors. If the capacitance value is lower than expected, replace the capacitor. • For the models RSBS…C10/C17/C24, check the value of the run capacitor. If the capacitance is lower than the rated value, replace the capacitor.

Number of flashes	6
Alarm	Internal over-temperature alarm
Alarm description	The RSBS will trigger this alarm if it measures an internal temperature > 115ºC for ≥ 1s
Alarm recovery period	Typically 5 mins – RSBS 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	• Check that there is proper ventilation around RSBS. • Ensure that the vents of RSBS are not obstructed.

Number of flashes	7
Alarm	Compressor running in reverse
Alarm description	The RSBS 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	• Check for unstable or low supply voltage level.

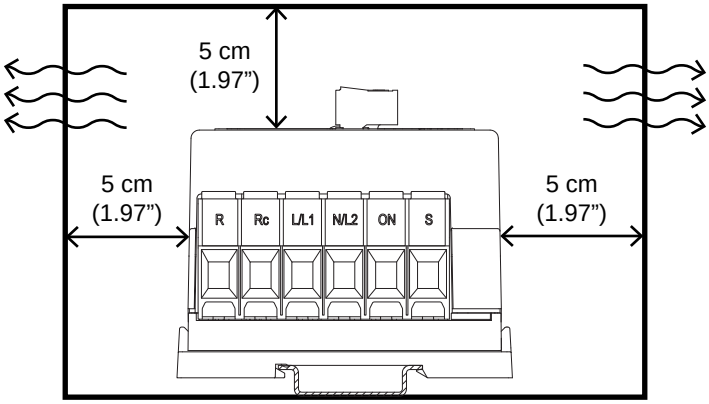
Number of flashes	8
Alarm	Load loss
Alarm description	This alarm will be triggered when the load current is ≤ 2 AAC for ≥ 1 mains cycle. The alarm will be active during ramp-up and bypass mode. Ramp-up: As soon as the ON signal is turned ON, the RSBS will start the ramp-up function. If the measured current is ≤ 2 AAC then the RSBS 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 RSBS 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 RSBS will re-trigger the alarm. The alarm will self-recover after 5 minutes.
Troubleshooting	• Check that the compressor (or a load > 2 Arms) is connected to the RSBS. • 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 RSBS detects a current on the “L” connection when it is in IDLE state. (Fault: Welded main relay). In this case the RSBS will trigger the alarm after 100 ms. 2. The RSBS detects a current > Imax HP during ramp-up state (Fault: SCR short or bypass relay welded). The RSBS 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 L and N through the main relay and run capacitor).
Troubleshooting	• Replace RSBS and contact your local Carlo Gavazzi representative. • Check compressor winding resistance and verify that this is within manufacturer specifications.

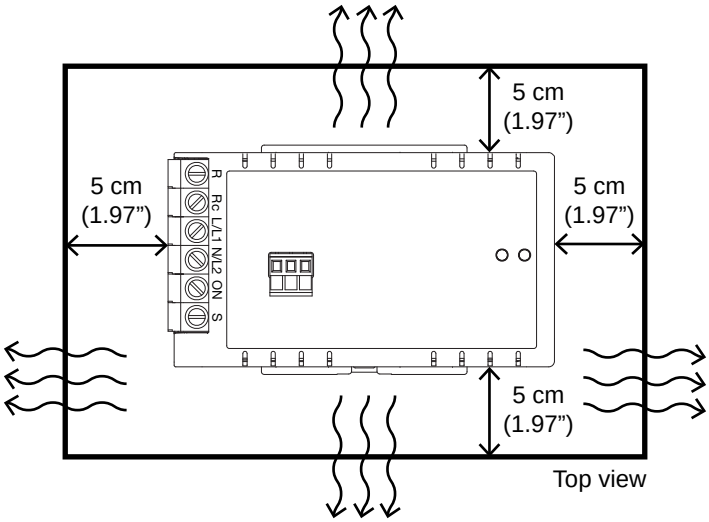
Number of flashes	Fully ON
Alarm	Critical over-temperature alarm
Alarm description	The RSBS will trigger this alarm if it measures an internal temperature >130ºC for ≥ 100 ms
Alarm recovery period	Alarm does not self-recover
Consecutive alarms for hard reset	1
Action to recover alarm	This alarm is considered to be a critical condition and the RSBS will immediately switch OFF its output. The alarm is non-resettable. Once this alarm is triggered the user needs to replace the RSBS.
Troubleshooting	• Check that there is proper ventilation around RSBS. • Replace the RSBS with a new one.

Installation

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



Front view



Top view

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 co-ordination Type 1 according to UL 60947-4-2

Part No.	Prospective short circuit current [kArms]	Max fuse size [A]	Class	Article no.
RSBS2332A2V23C..HP	5	45	RK5	FLSR45 (manufacturer: Littlefuse)