SAF Drives Inc.

Installation & Operating Procedures

Opal LT Series

RVS-AX Analogue Soft Starter
8-170A, 220V-600V
Manufactured By SOLCON

Supplied By

SAF Drives Inc.

SOLCON

RVS-AX

Analogue Soft Starter
8-170A, 220-600V

Instruction Manual

Ver. 3.2.04

Table of Contents

Safety

- Read this manual carefully before operating the equipment and follow its instructions.
- Installation, operation and maintenance should be in strict accordance with this manual, national codes and good practice. Installation or operation not performed in strict accordance with these instructions will void manufacturer's warranty.
- Disconnect all power inputs before servicing the soft-starter and/or the motor.
- After installation, check and verify that no parts (bolts, washers, etc) have fallen into the starter.

Attention

1. This product was designed and tested for compliance with IEC947-4-2 for class A equipment.
2. Use of the product in domestic environments may cause radio interference, in which case the user may be required to employ additional mitigation methods.
3. Utilization category is AC-53a or AC53b. Form1.
4. For further information, see Technical Specification.

Warnings

- Internal components and P.C.B's are at Mains potential when the RVS-AX is connected to mains. This voltage is extremely dangerous and may cause death or severe injury if contacted.
- When RVS-AX is connected to Mains, even if start signal has not been issued, full voltage may appear on motor's terminals. Therefore, for isolation purposes it is required to connect an isolating device (C/B, switch, line contactor, etc) upstream to the RVS-AX.
- Starter must be properly grounded to ensure correct operation and safety.
- Check that Power Factor capacitors are not connected to the output side of the soft starter

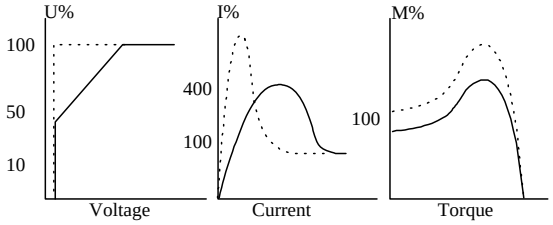
The company reserves the right to make any improvements or modifications to its products without prior notice.

Starter Selection

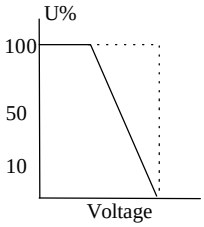
The RVS-AX electronic soft starter incorporates six thyristors to start a three-phase squirrel cage induction motor. By supplying a slowly increasing voltage, it provides soft start and smooth stepless acceleration, while drawing the minimum current necessary to start the motor.

A Soft Stop feature can be enabled when the Ramp-Down potentiometer is adjusted. When used, upon stop signal (open contact terminals 1 and 2), motor's voltage is slowly reduced to zero.

Soft-Start Characteristics



Soft-Stop Characteristics



The Soft-Stop characteristic may be used for controlled deceleration of pumps and high friction loads.

RVS-AX ratings and Frame sizes

Max. Motor FLA (Amp)	Starter Type FLC (Amp.)	Frame Size (Aluminum)
8	RVS-AX 8	A1
17	RVS-AX 17	
31	RVS-AX 31	
44	RVS-AX 44	
58	RVS-AX 58	A2
72	RVS-AX 72	
85	RVS-AX 85	A3
105	RVS-AX 105	
145	RVS-AX 145	A4
170	RVS-AX 170	

Dimensions (mm) & Weights (Kg)

Size	Width	Height	Depth	Weights (Kg)
A1	120	232	105	2.6
A2	129	275	185	5
A3	129	380	185	8.4
A4	172	380	195	11.8

The starter should be selected in accordance with the following criteria:

1. Motor Current & Starting Conditions

Select the starter according to motor's Full Load Ampere (FLA) - as indicated on its nameplate (even if the motor will not be fully loaded).

The RVS-AX is designed to operate under the following maximum conditions:

Ambient Temp.	I start	Acc. Time
40° C	300% In	30 Sec
	350% In	20 Sec
	400% In	5 Sec

Max. Starts per Hour: four (4) starts per hour at maximum ratings and up to 10 starts per hour at light load applications (consult factory).

Note: For very frequent starts (inching applications) the inching current should be considered as the Full Load Current (FLC) – consult factory.

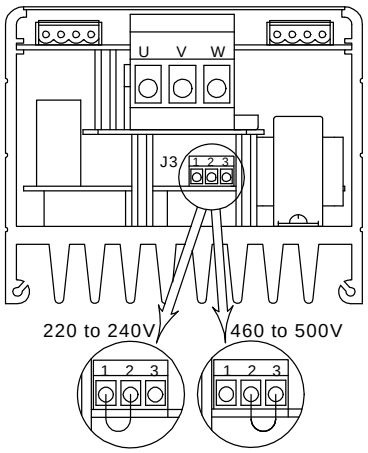
2. Mains Voltage

Each starter is factory set for one of the following levels according to the Ordering Information.

Voltage	Tolerance
380 - 415 V	+10 -15 %
440 V	+10 -15 %
460 - 500 V *	+10 -15 %
575 - 600 V	+10 -15 %

Frequency: 50 / 60 Hz.

* Starter's rated 460-500VAC can be field modified for system voltage of 220-240V, by placing the internal Jumper J3 as shown below.



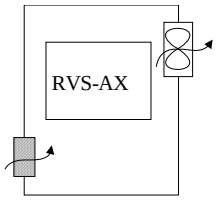
Installation Notes

Prior to Installation
Check that Motor's Full Load Ampere (FLA) is lower than or equal to starters Full Load Current (FLC) and that Mains voltage is as indicated on the front panel.

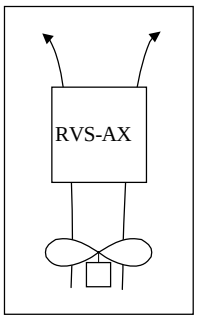
Mounting
- The starter must be mounted vertically. Allow sufficient space above and below the starter for suitable airflow.
- It is recommended to mount the starter directly on the rear metal plate of the switchgear for better heat dissipation.
- Do not mount the starter near heat sources.
- Protect the starter from dust and corrosive atmospheres.

Temperature Range and Heat Dissipation
The starter is rated to operate over a temperature range of –10°C (14°F) to +40°C (104°F).
Relative non-condensed humidity inside the enclosure should not exceed 93%.
The heat dissipation during continuous operation is Approx. 0.4 x In (in watts).
Example: When motor's current is 100 Amp, heat dissipation will be approx. 40 watts.
Internal enclosure heating can be reduced using additional ventilation.

Additional Ventilation



General purpose enclosure with filter on the air inlet and Fan on air outlet.



Fan, creating air circulation

Voltage Spike Protection
Voltage spikes can cause malfunction of the starter and damage the SCRs. When expected, use suitable protection such as Metal Oxide Varistors (consult factory for further details).

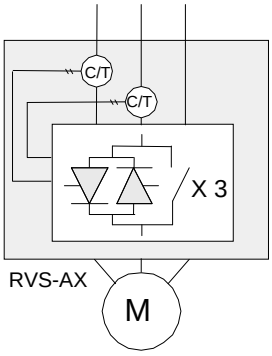
Short Circuit Protection
The RVS-AX should be protected against a short circuit by Thyristor Protection fuses.
The recommended I^2t values are:

RVS-AX type	I^2t (A^2S)	Ferraz Fuses
RVS-AX 8	400	6,6 URS 35
RVS-AX 17	2,000	6,6 URS 45
RVS-AX 31	3,000	6,6 URS 63
RVS-AX 44	6,000	6,6 URB 100
RVS-AX 58	12,000	6,6 URB 150
RVS-AX 72	18,000	6,6 URB 160
RVS-AX 85	40,000	6,6 URD 200
RVS-AX 105	60,000	6,6 URD 250
RVS-AX 145	100,000	6,6 URD 355
RVS-AX 170	140,000	6,6 URD 400

Caution
Power factor correction capacitors must not be installed on starter's Load side. When required, Install capacitors on the Line side.

Warning
When Mains voltage is connected to the starter, even if start signal has not been initiated, full voltage may appear on the starter's load terminals. Therefore, for isolation purposes it is required to connect an isolating device (C/B, switch, line contactor, etc) upstream to the RVS-AX (on the Line Side).

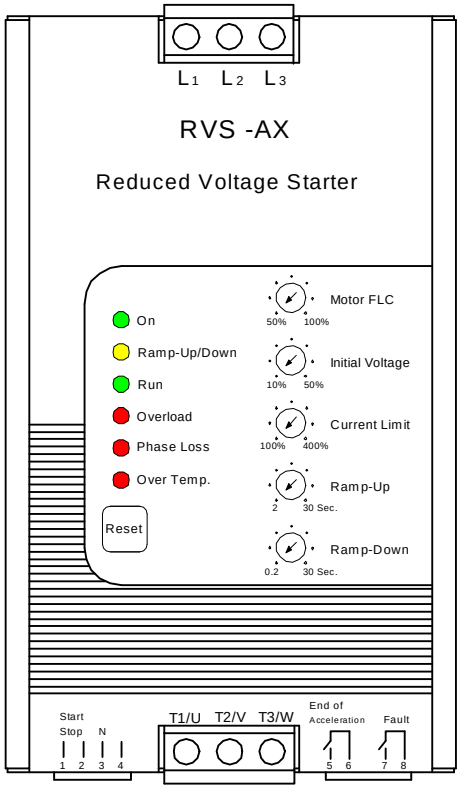
Built-in Bypass
The RVS-AX incorporates internal bypass relays allowing current flow through the thyristors only during starting process. At the end of the starting process, the built-in relays bypass the thyristors and carry the current to the Motor.



Upon stop signal, or in case of fault, all three bypass relays will open and stop the motor.
When Ramp-Down potentiometer is set to allow soft-Stop process, upon stop command, the bypass relays will open immediately and the current will flow through the thyristors. The voltage will then be reduced slowly and smoothly to zero.

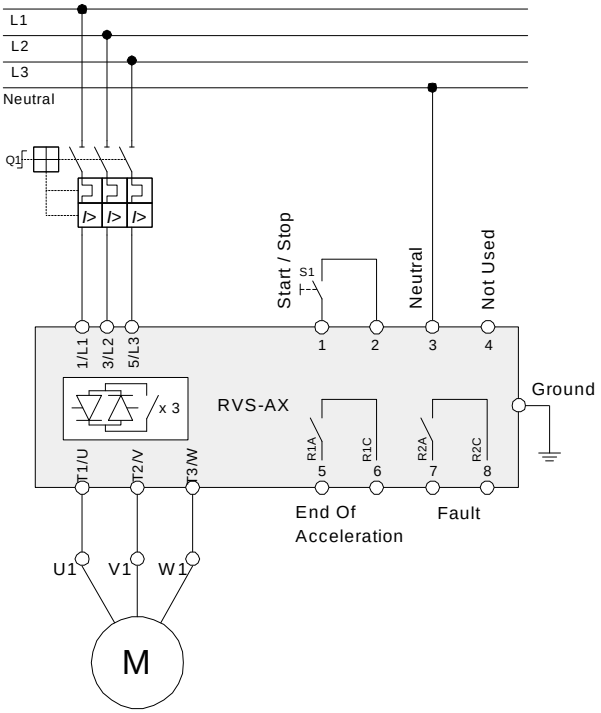
Wiring

Block and Connection Diagram



NOTE: The RVS-AX incorporates an internal control voltage transformer connected to phases L1&L3, in case of phase loss of L1 or L3 the starter will stop the motor. In case of phase loss for L2 the phase loss fault will trip the starter only if Terminal 3 – Neutral, is used).

Connection Diagram



Stop / Start ..... Terminals 1 - 2
By voltage free contact (Dry contact)
Close: Start command.
Open: Stop command.

> **Warning**
> Do not apply voltage to terminals 1 - 2.

Neutral ..... Terminal 3
Neutral wire (when used) is required only for operation of the Phase Loss Protection (Phase Loss can not be detected when Neutral is not connected to Terminal 3). See detailed description in “Phase Loss” explanation.

Open terminal – not connected **..... Terminal 4**

End of Acceleration (E.O.A) ..... Terminals 5 - 6
Voltage free, N.O., 8A / 250VAC, 2000VA max.
The contact closes after the time adjusted on the "Ramp-Up" potentiometer. The contact returns to its original position on stop signal, on fault condition, upon voltage outage and at the beginning of Soft Stop.

Use of E.O.A. Contact
This contact can be used for:

- Activating a valve after a compressor has reached full speed
- Loading a conveyor after the motor has reached full speed.

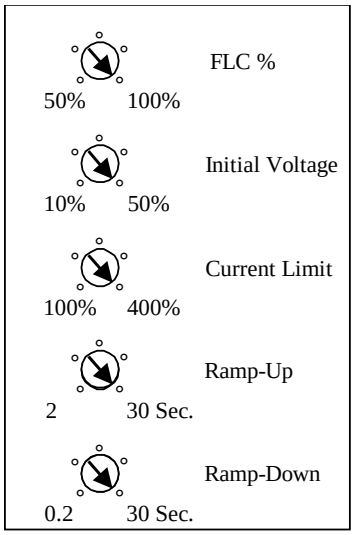
Fault contact ..... Terminals 7 - 8
Voltage free, N.O., 8A / 250VAC, 2000VA max.
The contact closes upon operation of any fault. The contact returns to its original position (after the fault has been removed) upon reset, or upon disconnection the Mains voltage.

> **Warning**
> Do not use the Fault contact to trip an upstream contactor. When the Fault contact trips the upstream contactor, Mains voltage will be disconnected, thus resetting the starter and the motor will restart instantaneously upon voltage restoration (see Fault Resetting).

> **Warning**
> Start/Stop with a maintained contact!
> When the line contactor is operated by a maintained contact, in case of Mains failure, the motor will be automatically restarted upon voltage restoration.
> When resetting after a fault with the Reset button, the motor will restart upon fault reset.
> It is therefore recommended not to connect the fault relay to the line contactor.

Starter Settings

Front Panel Layout



FLC - Full Load Current (Motor FLC)

The adjustment allows easy setting of the RVS-AX current level, automatically adjusting current based functions (Overload, Current Limit, etc).

Set FLC potentiometer according to the following equation:

$$FLC = \frac{\text{Motor FLA}}{\text{FLC}} \times 100$$

Where:

Motor FLA is the motor's Full Load Current rating as shown on its nameplate.

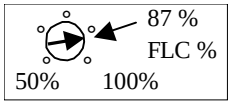
FLC is the starter Full Load Current as shown on its label.

Example:

When starting a 27A motor using RVS-AX 31:

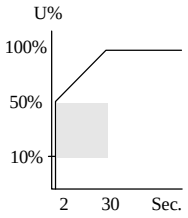
$$FLC\% = \frac{27}{31} \times 100 = 87\%$$

Therefore set the FLC% to a reading of 87% (see Ex.)



Initial Voltage

Determines the initial voltage to the motor (torque is directly proportional to the square of the voltage).



Range: 10-50% of nominal voltage.

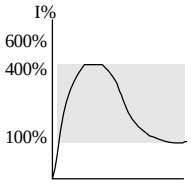
This adjustment also determines the inrush current and mechanical shock.

Too high of a setting may cause high initial mechanical shock and high inrush current (even if Current Limit is set low, as the Initial Voltage setting over-rides the Current Limit setting).

Too low of a setting may result in prolonged time until motor starts revolving. The motor should start revolving immediately after Start signal.

Current Limit

Determines motor's highest current during starting.



Range is 100-400% of FLC (as set on starter's FLC adjustment).

Too high of a setting will allow higher currents to be drawn from Mains, resulting in faster acceleration.

Too low of a setting may prevent the motor from completing the acceleration process and reaching full speed.

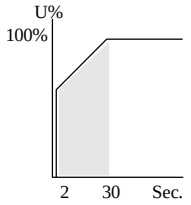
Generally, this setting should be set to the highest acceptable value in order to prevent stalling.

Caution

Starting Current should not exceed the allowable conditions as shown in page 3.

Ramp-up Time

Determines motor's voltage ramp-up time from initial to full voltage.



Range: 2-30 sec.

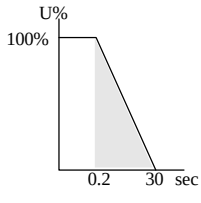
It is recommended to set Ramp-Up Time to the minimum acceptable value (approx. 5 Sec).

Notes:

1. Setting Current Limit low will extend Ramp-Up Time.
2. When motor reaches full speed before voltage reaches nominal, Ramp-Up Time adjustment is overridden, causing voltage to quickly ramp up to nominal.

Ramp-Down time (Soft-stop)

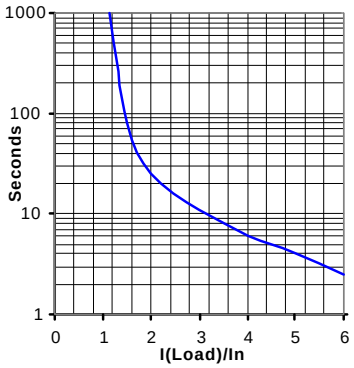
Used to control deceleration of high friction loads. When Ramp-Down potentiometer is set, upon stop signal the starter output voltage is gradually ramped down.



Range: 0.2-30 sec. When "Ramp-down Time" is set to minimum, the motor will stop immediately.

Motor Protection

Electronic Overload



The built-in inverse time electronic overload becomes operational after end of acceleration process. Trip current is factory set to 115% of Motor Full Load Current (from the setting on Motor FLC potentiometer),
E.g. In order to increase the O/L trip point; increase FLC setting above the calculated level. Trip time varies from 60 sec. at 150% of nominal current to 2 sec. at 600% of nominal current.

Phase Loss

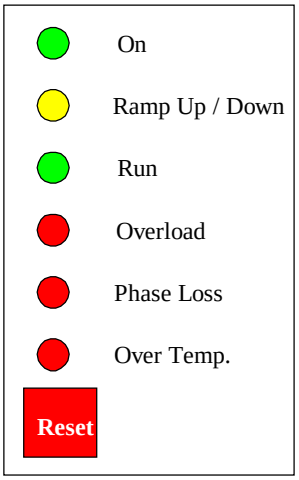
The protection becomes operational when the starter is energized; it protects the motor from single phasing. It will trip the starter when one or two phases are missing for more than 1 sec.

When phase loss occurs during starting or when motor is not loaded, it may happen that motor will stop without accurate indication of the Phase Loss LED.

Note: Phase loss protection operates only when Terminal 3 is connected to Neutral.

Fault Logic, Alarm and Reset Circuits

Upon operation of any protection, the starter locks in a fault mode, disabling thyristors firing. The proper fault indication LED lights and the Fault contact closes. To reset the starter, after the fault has been removed, press Reset button on starter's front panel or disconnect Mains voltage.



Heatsink Over temperature Protection

A thermal sensor mounted on the heatsink trips the starter when its heatsink temperature rises above 85ºC.

Warning

The Over-temperature Protection is designed to operate under normal conditions and will operate incase abnormal conditions occur:

- Incorrect starter selection
- Too frequent starting at max. conditions
- Repeated starting under fault conditions
- Extended low overload
- Insufficient ventilation
- Other abnormal conditions

Note- In case of frequent starting the internal thyristors may overheat before the heatsink reaches its over-temperature protection of 85°C, thus causing component malfunction.

Caution

When starter is operated by a maintained contact, resetting the fault will start the motor immediately.

Warning

Do not use the Fault contact to trip an upstream contactor. When the Fault Contact closes on fault and trips the upstream contactor, Mains voltage will be disconnected, thus resetting the RVS-AX and the motor will restart instantaneously (see Fault Resetting).

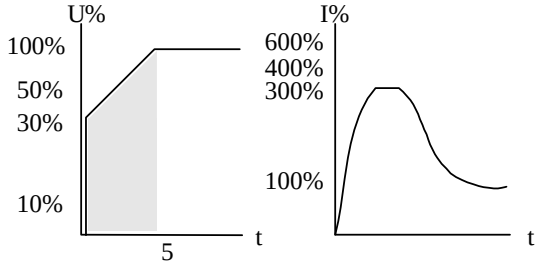
Startup Procedure

1. Set FLC (Motor Full Load Current) - according to
2. Calculation: $\text{FLC} = \frac{\text{Motor FLA}}{\text{Starter FLC}} \times 100$
3. Set other potentiometers according to system requirements (see next column for examples)
4. Connect Mains voltage to starter Line terminals.
5. Start the motor, if it begins revolving shortly after start signal proceed to Para. 5. If not, increase Initial Voltage setting until motor starts to turn shortly after start signal.
   When initial inrush current and mechanical shock are too high, decrease Initial Voltage setting and proceed to Para 6.
6. Motor begins to turn. If speed smoothly accelerates to nominal proceed to Para 6. If current during acceleration is too high, slightly decrease Current Limit setting. If motor speed does not increase to nominal, increase Current Limit setting.
7. Disconnect the start command (open Terminals 1 and 2) and wait until the motor stops.
8. Slightly increase Initial Voltage and Current Limit adjustments to allow for load variations.
9. Start the motor again and verify that acceleration process to full speed is as required.
10. If acceleration time is too short, increase Ramp-Up time setting.

When Soft stop is required, set Ramp-Down Potentiometer to the required time (minimum deceleration time is recommended).
Check that soft stopping process is as required.

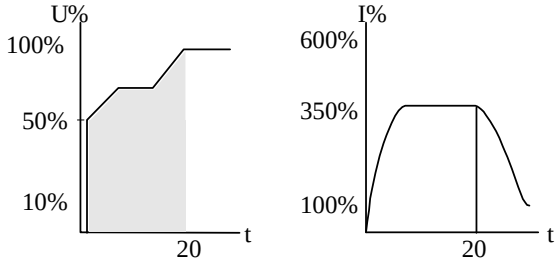
Note:
If Ramp Down potentiometer is not in the minimum setting. Emergency stop may be performed by disconnecting the mains voltage.

Examples of Starting Curves
Light Loads - Pumps, Etc.
Current limit - set to 300%
Initial Voltage - set to 30%
Ramp-up time - set to 5 sec.



Upon start, the voltage quickly increases to the Initial Voltage value (30% Un) and then gradually ramps-up to nominal.
The current will simultaneously increase to peak current value, which can be the Current Limit setting or less, before smoothly decreasing to the operating current. The motor will accelerate to full speed quickly and smoothly.

High inertia loads – Crushers, Centrifuges, Mixers Etc.
Current Limit - set to 350%
Initial Voltage - set to 50%
Ramp-Up time - set to 5 sec.



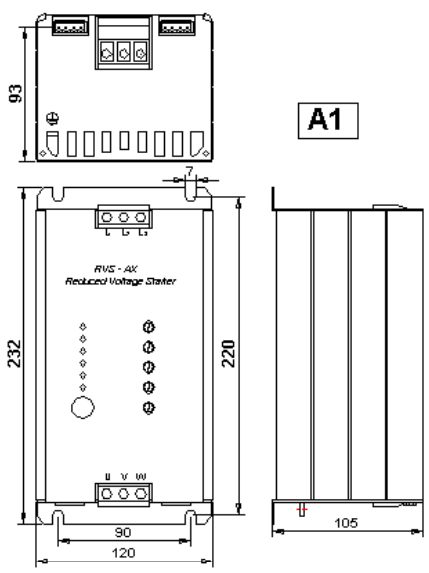
Upon Start the voltage and current increase until current reaches Current Limit value. The voltage remains at this value until motor reaches nominal speed, where current starts to decrease, voltage continues to ramp-up to nominal. At this time, the motor should have smoothly accelerated to full speed.

Technical Specification

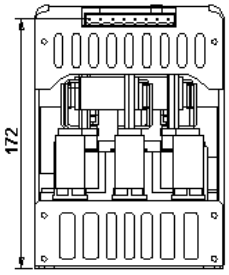
Environment		
Supply voltage	Three phase, line to line, 380 – 415 Vac +10% -15% 460 – 500 Vac +10% -15% * 575 – 600 Vac +10% -15%	* 460 – 500 Vac is applicable for 220 – 240 Vac by changing the position of the internal jumper – J3. As shown in page 3.
Frequency	50 / 60 Hz	
Load	Three-Phase, Three-Wire, Squirrel Cage Induction Motor	
Degree of protection	IP 20	
Altitude	1000 m above sea level	Consult factory for derating
Adjustments		
FLC (Full Load Current)	50% - 100%	
Starting Torque (Initial Voltage)	10-50 % of full voltage	
Current limit	100 % - 400% of nominal current	
Ramp Up Time (soft start)	2 - 30 sec.	
Ramp Down Time (Soft Stop)	0.2 - 30 sec.	
Protection		
Electronic Overload	Inverse time (I^2t), factory preset at 115% of FLC, active only during Run.	
Phase Loss	Trips when one phase is missing (When Neutral is connected)	
Heatsink Over temperature	Trips when the heatsink temperature exceeds 85ºC.	
Reset buttons	To reset the starter, after the fault has been removed.	
Indications		
Indication lights (LEDs)	ON - Green	Lights when three phases are connected to the RVS-AX.
	Ramp Up / Ramp Down – Yellow	Lights upon start signal or during soft stopping.
	RUN – Green	Lights upon end of starting. When the internal bypass relays close.
	Overload – Red	Inverse time electronic overload becomes operational after the End Of Acceleration process (see page 7).
	Phase loss – Red	Lights when one or two phases are missing for more than 1 sec.
	Over temperature – Red	Lights on and trips the starter when the heatsink temperature rises above 85ºC.
Temperatures		
Operating	-10° to 40°C	
Storage	-20° to 70°C	
Relative humidity	93 % - non condensed	

EMC		
Immunity to radio electric interference	EN 1000-4-3 level 3	Conforming to EN 60947-4-2
Electrostatic discharge	EN 1000-4-2 level 3	Conforming to EN 60947-4-2
Immunity to electrical transients	EN 1000-4-4 level 4	Conforming to EN 60947-4-2
Shock waves of voltage / current	EN 1000-4-5 level 3	Conforming to EN 60947-4-2
Radiated and conducted emissions	EN 1000-4-6 level 3	
Radio frequency emissions	According to EN 55011 class A	Conforming to EN 60947-4-2
Mechanical		
Shock resistance	8 gn	Conforming to EN 60947-4-2
Vibration resistance	2 gn	Conforming to EN 60947-4-2
Output relay		
End of Acceleration Contact	N.O.	
Rated operating current	5 A, 250 V - Size A1 8 A, 250 V – Size A2	

Dimensions



A1



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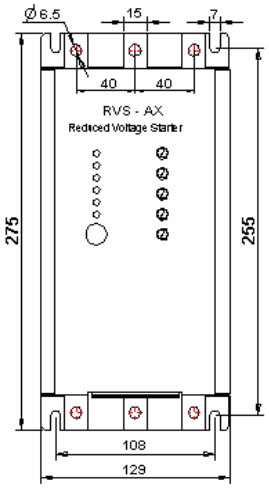
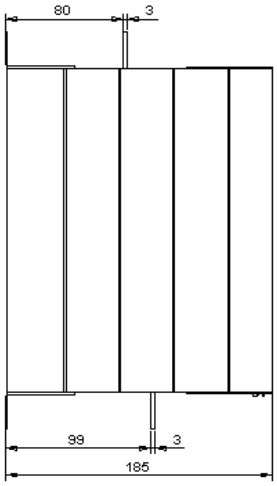
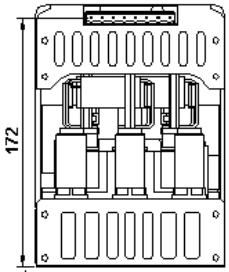
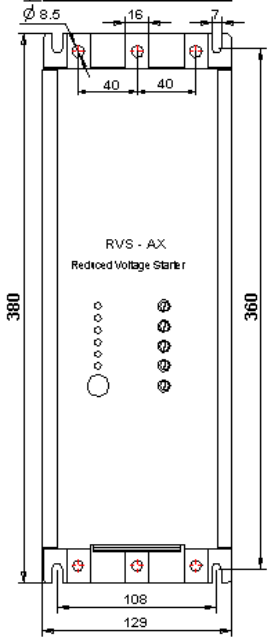
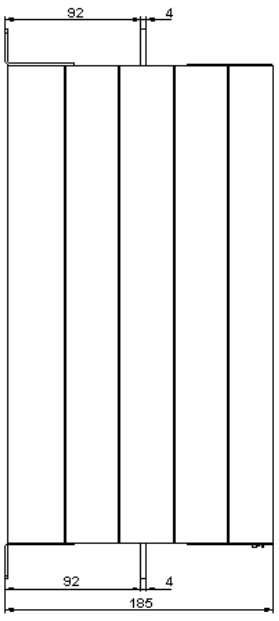


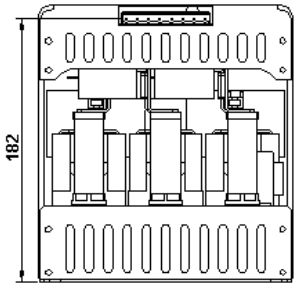




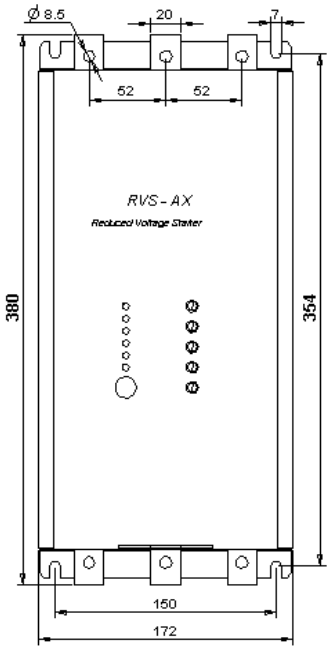
A3

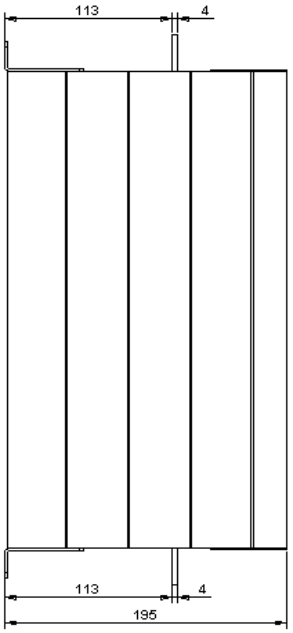






A4





Power & Control Connections

Starter Type FLA (Amp)	Size	Power Connections	Control Connections
RVS-AX 8	A1	Terminals 16mm ^{2}	Terminals 1.5mm ^{2}
RVS-AX 17			
RVS-AX 31			
RVS-AX 44			
RVS-AX 58	A2	Bus Bars 15x3mm	
RVS-AX 72			
RVS-AX 85	A3	Bus Bars 16x4mm	
RVS-AX 105			
RVS-AX 145	A4	Bus Bars 20x4mm	
RVS-AX 170			

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