RVS-AXO

Digital Soft Starter with Internal ByPass

3.5-75A, 400 / 500V

Instruction Manual

Ver. 1019

INSTRUCTION MANUAL

TABLE OF CONTENT

2. **SAFETY & WARNINGS**

2.1 Safety

	**1**	Read this manual carefully before operating the equipment and follow its instructions.
	2	Installation, operation and maintenance should be in strict accordance with this manual, national codes and good practice.
	3	Installation or operation not performed in strict accordance with these instructions will void manufacturer's warranty.
	4	Disconnect all power inputs before servicing the soft-starter and/or the motor.
	5	After installation, check and verify that no parts (bolts, washers, etc.) have fallen into the starter.
	6	Due to movements that may have occurred during shipment, it is recommended to initialize the soft-starter by connecting the supply voltage prior to operating the soft-starter with a motor.

2.2 Warnings

	**1**	Internal components and P.C.Bs are at main potential when the RVS-AXO is connected to the mains. This voltage is lethal if connected and extreme care should be taken.
	2	When the RVS-AXO is connected to the mains, even if the start command has not yet been issued and the motor is stopped, the starter's output and motor's terminals may show full a voltage status. Therefore, there is a requirement that an isolation device be connected upstream to the RVS-AXO so as to ensure isolation.
	3	The starter must be properly grounded to ensure correct operation, safety and to prevent any damage.
	4	Check that the Power Factor capacitors are not connected to the output side of the soft starter.
	5	Do not interchange line and load connections

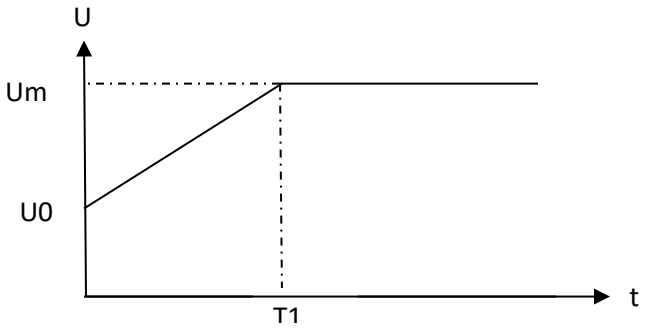
3. TECHNICAL DATA

3.1. Introduction

The RVS-AXO is a starter designed for use with standard three-phase, three-wire, squirrel cage, induction motors.

It provides the best method of reducing current during motor starting.

The RVS-AXO starts the motor by supplying a slowly increasing voltage, providing a soft start and smooth acceleration, while drawing the minimum current necessary to start the motor.



Um – mains voltage

U0 – initial voltage

T1 – voltage rise time

The RVS-AXO is equipped with an internal by-pass controlled by its micro-controller. The by-pass closes after the the starting process has ended, thus reducing heating and saving power.

3.2 Rating and Frames Sizes

Frame	Starter type	Starter FLC [A]	Dimensions WxHxD [mm]	Weight [Kg]
A	RVS-AXO 3	3	175*92*95	0.8
	RVS-AXO 4.5	4.5	175*92*95	0.8
	RVS-AXO 7.5	7.5	175*92*95	0.8
	RVS-AXO 11	11	175*92*95	0.8
B	RVS-AXO 15	15	200*108*105	1
	RVS-AXO 22	22	200*108*105	1
C	RVS-AXO 30	30	222*125*132	2
	RVS-AXO 37	37	222*125*132	2
	RVS-AXO 45	45	222*125*132	2
	RVS-AXO 60	60	222*125*132	2
	RVS-AXO 75	75	222*125*132	2

3.3 Ordering Information

RVS-AXO	3-	400-	230-	3M-	S
	Full load Current	Mains Voltage	Control Voltage	Options	Front Panel

Full load Current	
Specify	**Description**
Starter's FLC [A]	3, 4.5, 7.5, 11, 15, 22, 30, 37, 45, 60, 75

Mains Voltage	
Specify	**Description**
400	400 VAC, 50/60Hz , +10% -15%
500	500 VAC, 50/60Hz , +10% -15%

Control Voltage	
Specify	**Description**
230	100-240VAC, 50/60Hz , +10% -15%

Options	
Specify	**Description**
0	No options
3M	Communication RS-485 Board (MODBUS)

Front Panel	
Specify	**Description**
S	Standard lexan

Example:

RVS-AXO rated 22A, mains voltage 400V:

RVS-AXO 22- 400 – 230 – 3M-S

4. RVS-AXO SELECTION

Selection of an RVS-AXO is according to the motor's Full Load Ampere (FLA) - as indicated on its label (even if the motor will not be fully loaded).

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

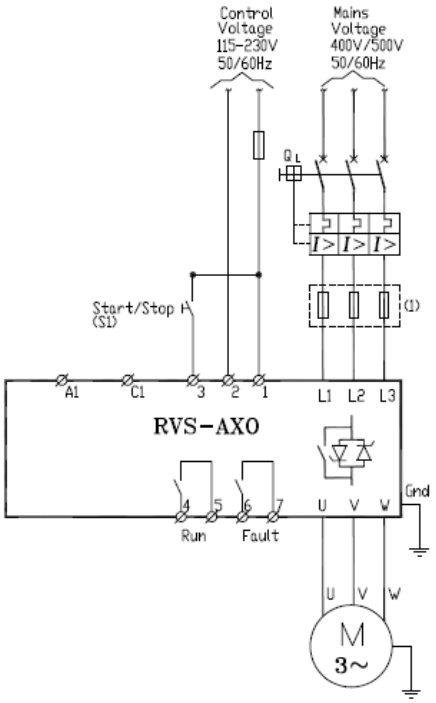
Ambient temperature ºC	Starting current (A)	Acceleration time(Sec)	Starts per hour
40	3 * In	7	6

When operating under ambient temperature higher than 40 ºC, the RVS-AXO nominal current decreases 0.8% / 1ºC.

When operating at an altitude above 1000m, the RVS-AXO nominal current decreases 1% / 150m.

5. RECOMMENDED WIRING SCHEMES

5.1. Typical Wiring Diagram



Notes:
(1) – Circuit breaker provides IEC type 1 coordination. Use fuses for IEC type 2 coordination. Refer to table below.

Model	SCR $i^2 * t$(A^2 * sec)	Fuse value
RVS-AXO 3	270	10A
RVS-AXO 4.5	610	16A
RVS-AXO 7.5	1700	25A
RVS-AXO 11	3630	32A
RVS-AXO 15	6750	32A
RVS-AXO 22	14250	50A
RVS-AXO 30	27000	63A
RVS-AXO 37	41070	100A
RVS-AXO 45	60750	125A
RVS-AXO 60	108000	125A
RVS-AXO 75	168750	200A

5.2. Control Supply (Terminals 1, 2

100-240VAC, 50/60Hz is required to power the electronic circuitry and the bypass.

5.3. Start / Stop Input (Terminal 3

Close contact between A2 and B1 to soft start the motor.
To stop the motor open the contact. If deceleration time is set to 0 Sec, then the engine stops in a minimum time, depending on its own power loss.

Commands to start / stop can also be sent via Modbus communication channel.

5.4. Run Contact (Terminals 4, 5)

It is voltage free, N.O. 5A, 250Vac contact.

Contact is closed when the bypass is closed (Run state of soft starter) and is open when the bypass is open (Stop, Soft Stop or Trip state of soft starter).

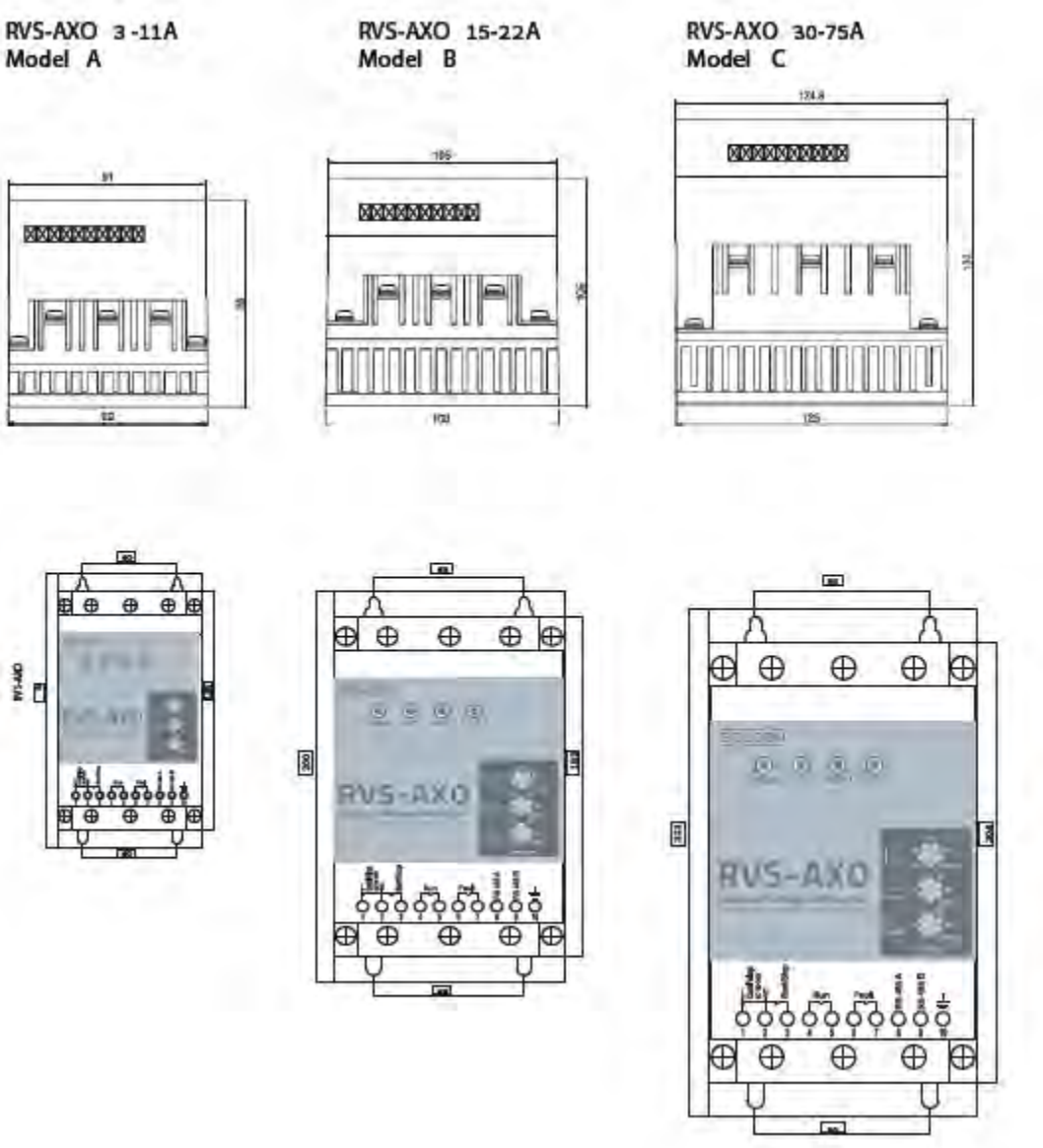
5.5. Fault Contact (Terminals 6, 7

It is voltage free, N.O. 5A, 250Vac contact.

Contact is closed when the soft starter is in a Trip state. To reset this state control voltage has to be disconnected and then reconnected.

Trip reset can also be done via Modbus communication channel.

6. DIMENSIONS



7. INSTALLATION

7.1 Prior to Installation

Check that Motor's Full Load Ampere (FLA) is lower than, or equal, to the starter's Full Load Current (FLC) and that the Mains and Control voltages are as indicated on the starter's side label.

7.2 **Mounting**

The starter must be mounted vertically. Allow sufficient space (at least 100mm) above and below the starter for sufficient airflow.

Do not mount the starter near a heat source.
Surrounding air temperature in the cabinet should not exceed 40ºC
Protect the starter from dust and corrosive atmospheres.

7.3 Power Wiring Instructions

- Input power and output motor field wiring shall be copper conductors, rated 75ºC.
- Minimal wire size, terminal screw and torque ratings for attachment to power inputs of RVS-AXO are presented below.

RVS-AXO	Terminals Screw	Minimal wire size (mm^2)	Mechanical Torque (N*m)
RVS-AXO 3	M5	2.5	3
RVS-AXO 4.5	M5	2.5	3
RVS-AXO 7.5	M5	2.5	3
RVS-AXO 11	M5	2.5	3
RVS-AXO 15	M5	2.5	3
RVS-AXO 22	M5	4	5
RVS-AXO 30	M5	4	5
RVS-AXO 37	M5	6	5
RVS-AXO 45	M6	10	5
RVS-AXO 60	M6	16	5
RVS-AXO 75	M6	16	5

8. OPERATION INTERFACE.

8.1. Control

- Initial voltage at Start and voltage rise (Start) / reduction time (Stop) set by 3 built-in potentiometers or via Modbus communication channel.

- Start / Stop command supplied by an external voltage free contact or via Modbus communication channel.

- Fault reset can be done by switching control voltage OFF / ON or via Modbus communication channel.

8.2. Control Terminals

#	Name	Duty
1	L	Control voltage (100-240Vac) phase input
2	N	Control voltage neutral input
3	Start / Stop	Connect 100-240Vac related to N to start the motor. Disconnect – to stop the motor.
4	Run relay NO	Closed in Start, Run and Soft Stop state of the starter.
5	Run relay common	
6	Fault relay NO	Closed in Fault state of the starter.
7	Fault relay common	
8	RS485 A-Line (+)	RS485, Modbus communication port.
9	RS485 B-Line (-)	
10	Ground	

8.3. User Interface

Potentiometers Description:

Potentiometer	Duty
	Set initial voltage to 30-70%.
	Set voltage rise time to 1-30Sec.
	Set voltage reduction time to 0-30Sec.

LEDs Description:

LED	duty
Power	Lights when RVS-AXO energized
Run	Blinks at start / soft stop. Lights when bypass is closed.
Fault 1	Blinks or lights when RVS-AXO is in fault state.
Fault 2	

9. PROTECTIONS

9.1 Protections List:

Fault	Active at			Setting range	Factory set
	Stop	Start / soft stop	Bypass		
Wrong phase sequence	x	v	v		
Phase loss / No voltage	x	v	v		
Over current instantaneous	v	v	v	850% FLA	850% FLA
Over current delayed				500-850% FLA with delay 0.1-1Sec.	500%, 0.1Sec
Overload	x	x	v	Pickup 100-200% FLA, Grade 10A, 10, 20, 30	110%, 10A
Current unbalance	v	v	v	20%	20%
Over Temperature	v	v	v	80ºC (heat sink temperature)	80ºC

Note:

Factory settings can be changed via Modbus communication channel.

9.2 Faults Display:

Fault	LED Fault 1	LED Fault 2
Wrong phase sequence	Blinks	
Phase loss / No voltage		Blinks
Over current		Lights
Overload	Lights	Blinks
Current unbalance	Lights	
Over Temperature	Blinks	Lights

9.3 Overload Trip Time

Overload trip delay depends on motor initial state (cold / hot), motor current, selected overload protection grade and selected overload protection pickup.

Delays for hot motor and selected pickup = 115% FLA are presented below:

Overload grade	Motor current %FLA						
	800	700	600	500	400	300	200
10A	1.6Sec	2Sec	3Sec	4Sec	6Sec	12Sec	26Sec
10	3	4	6	8	13	23	52
20	5	6	9	12	19	35	78
30	7	9	13	19	29	52	112

10. SETTING PARAMETERS

Those parameters can be changed via Modbus communication channel.

Parameter	Setting range	Factory setting
Starter FLC	1-100A	According to RVS-AO model
Motor FLA	1-100A	According to RVS-AO model
Start parameters setting	0 – by potentiometers 1 – by Modbus channel	0
Initial Voltage at Start	1 – 15 (1 ->30%, 15 ->70%)	Applicable when [Start parameters setting] set to Modbus channel
Voltage rise time at Start	1 – 15 (1 ->1Sec, 15 -> 30Sec)	
Voltage reduction time at stop	1 – 15 (1 ->0Sec, 15 -> 30Sec)	
Over current trip level	500-850%FLA	500%
Over current trip delay	0.5 – 1Sec	0.5Sec
Overload protection pickup	100 – 200%FLA	115%
Overload protection grade	0 – 10A 1 – 10 2 – 20 3 - 30	10A
Phase sequence protection	0 – OFF 1 - ON	ON
Modbus Address	1 - 127	1
Baud Rate	0 - 1200 1 – 2400 2 – 4800 3 – 9600 4 - 19200	9600
Parity check	0 – Even 1 – Odd 2 - None	Even

COMMUNICATION MANUAL

TABLE OF CONTENT

INTRODUCTION

This document summarizes the serial link protocol to / from the DIGITAL SOFT STARTER (RVS-AXO).

Features:

* RS485 Hardware.
* Asynchronous serial link.
* Half duplex.
* Format: **Modbus RTU Mode** (Remote Terminal Unit Mode).
  - Binary,
  - Each character includes 11 bits:
    - 1 start bit
    - 8 data bits, least significant bit is sent first.
    - 1 Parity bit, Select either Even / Odd / No
    - 1 Stop bit - if Parity is used, 2 stop bits - if Parity is not used.
    - **C**yclical **R**edundancy **C**heck (CRC), 16 bits.
* Baud Rates: 1200/2400/4800 / 9600/19200 bits per second..
* Response time of the RVS-AXO:
  - Normally, 4ms <= time response <= 40mS .
  - For a long response, time response <= 200mS.
* Frequent transmission to the RVS-AXO is not recommended, at a faster rate than once per second, so as to avoid the slowdown of RVS-AXO time delays.
* After the storage of setting parameters, Transmission to the same RVS-AXO can only be done after at least 1 Sec.
* Broadcast commands: not supported.

Notes:

* **Earth must be connected to the RVS-AXO earth terminal before the connection of serial link wires. Ignoring this instruction may result in permanent damage to the Serial Link Hardware.**

* **While in Start / Soft Stop state the RVS-AXO is busy controlling its SCRs and Will not respond to requests.**

* It is recommended to connect 120 OHM resistors on both ends of the serial link.
* Turn off (and on again) the control power after changing Baud_Rate, Parity_Check or Serial_Link_No (Slave Address).

BASIC STRUCTURE OF THE SERIAL LINK FRAME

Modbus RTU frame has the same principal structure for both the "Query" transmission from the Master to the Slave (RVS-AXO) and the Response transmission from the Slave to the Master.

"sync":	Silent time of at least 3.5 character (3.5 * 11 bit times).	
byte 1:	Serial Link No. (= Slave Address)	(1..247)
byte 2:	Function	(1,2,3,4,5,6,8,15 &16 are supported)
byte 3:	Data Bytes	($XX)
.	.	($XX)
.	.	($XX)
byte n-1:	CRC_Low	($XX)
byte n :	CRC_High	($XX)
"sync":	Silent time of at least 3.5 character (3.5 * 11 bit times).	

SYNC (Silent Interval)

In RTU mode messages, "synchronize" by a "Silent Interval" of more than 3.5 character times. This silent interval separates between transmission frames.
The entire frame must be transmitted as a continuous stream. A silent time of more than 3.5 character times during the frame transmission will cause the receiving device to ignore the incomplete frame. Next byte will be assumed as the Serial Link No. of the next frame.
Same result of ignoring the frame can occur if a second message is transmitted before 3.5 character times from the end of the previous one. This will cause the receiving device to consider it as a continuation of the first frame, resulting with CRC error.

SERIAL LINK NO. (SLAVE ADDRESS)

Contains RVS-AXO Slave Number (1-127) on the serial link. The RVS-AXO default value is 1. Serial Link No. is used as the first byte in both the "Query" transmission from Master to Slave and in Response transmission from Slave to Master.

FUNCTION

The Function code informs the RVS-AXO what the requested action is. In normal circumstances Function is used as the second byte in both the "Query" transmission from Master to Slave and in Response transmission from Slave to Master.

LIST OF FUNCTIONS SUPPORTED BY THE RVS-AXO

Function	Modbus Name	Use in RVS-AXO
01	Read Coil Status	Read Discrete Commands status.
02	Read Input Status	Read Discrete Inputs status.
03	Read Holding Registers.	Read Setting Parameters.
04	Read Input Registers.	Read actual data.
05	Force Single Coil.	Force one discrete command.
06	Preset Single Register.	Write one setting parameter.
08	Diagnostics.	Loopback Diagnostics.
15	Force Multiple Coils.	Force Discrete Commands.
16	Force Multiple Registers	Write Setting Parameters Control Commands

DATA

Data field includes information transferred to and from the RVS-AXO. The specific data format is changed with the Function. When Word data parameters are transmitted, High Byte is transmitted first, followed by the Low Byte.

CRC

The CRC (Cyclic Redundancy Check) two bytes (16 bit) are used to check the entire frame bytes. It is generated in the master device and transmitted as the last two bytes of the frame (Low byte is appended first followed by the High byte). The slave device generates the CRC bytes again and compares it to the received CRC bytes. If the CRC bytes are not identical, the frame is flushed and no response is transmitted to the master.

ACTUAL DATA (Input registers)

Actual data includes measured values such as currents and mains frequency. It also includes logic information in addition to statistic information. All parameters are **word** (two bytes) parameters. The protocol supports only Reading of these parameters.

Address	Register	Range / Unit	Note
0	Phase L1 current	%FLA	
1	Phase L2 current	%FLA	
2	Phase L3 current	%FLA	
3	Initial Voltage	0...512 (0~70%, 512~30%)	Represent potentiometers state.
4	Voltage rise time at start	0..512 (0~30, 512~1 Sec)	
5	Voltage reduction time	0…512(0~30,512~0 Sec)	
6	Average current	%FLA	
7	Mains Frequency	Hz	
8	RVX-AXO status	1~Stop, 129~Fault,	
9	Hardwire inputs	0~ Start / Stop open, 1~ Start / Stop closed	
10	Fault status	Code-2 of active fault. See faults list below.	
11	Accumulated running time	Hours	
12	Accumulated running time	Tenth of a second.	
13	Number of starts		
14	Number of faults		
15	Reserved		
16	Code-1 of 10 last faults.		
17			
18			
19			
20			
21			
22			
23			
24			
25			

Faults list:

Fault	Code-1	Code-2	
Over temperature	**1**	**1**	
Phase loss/ no voltage	**2**	**2**	
Over current	**3**	**4**	
Over load	**4**	**8**	
Current unbalance	**5**	**16**	
Negative phase sequence	**6**	**32**	

Example 1:

To read input registers at addresses 0…2 (Phase currents I1, I2, I3) of RVS-AXO # 18 the host computer should send following frame:

byte 1: Serial Link No. ($12)
byte 2: Function ($04)
byte 3: Starting Address High ($00)
byte 4: Starting Address Low ($00)
byte 5: No. of Points High ($00)
byte 6: No. of Points Low ($03)
byte 7: CRC_Low ($XX)
byte 8: CRC_High ($XX)

The RVS-AXO response, when Current = 80, 81, 82 % FLA, is:

byte 1: Serial Link No. ($12)
byte 2: Function ($04)
byte 3: Byte Count ($06)
byte 4: Data High, I1 ($00)
byte 5: Data Low, I1 ($50)
byte 4: Data High, I2 ($00)
byte 5: Data Low, I2 ($51)
byte 6: Data High, I3 ($00)
byte 7: Data Low, I3 ($52)
byte 8: CRC_Low ($XX)
byte 9: CRC_High ($XX)

Note: $XX indicates Hexadecimal byte.

SETTING PARAMETERS (Holding registers)

All parameters are word (two bytes) parameters**.** The protocol supports Reading with function 3 and modifying these parameters with functions 6, 16.

Any one of these parameters must modify with care. Harmful results can occur both to the motor and the RVS-AXO by inadequate settings of some parameters.

Address	Register	Range / Unit	Factory setting
0	RVS-AXO FLC	3…75A	According to RVS-A model
1	Motor FLA	3…75A	According to RVS-A model
2	Reserved		
3	Reserved		
4	O/C protection level	500…850%FLA	500%
5	O/C protection delay	1..10 tenth second	1 (0.1sec)
6	O/L protection pickup	100…200%FLA	110%
7	O/L protection grade	0-grade10A 1-grade10 2-grade 20 3-grade 30	0-grade10A
8	Reserved		
9	Initial Voltage	0…15 (30…70%)	Effective only when register @12 set to 1 / Modbus control. Otherwise potentiometers position define start / stop param.
10	Voltage rise time at start	0…15 (1…30Sec)	
11	Voltage reduction time at stop	0…15 (0…30Sec)	
12	Parameters setting	0 – potentiometer setting 1 – Modbus setting	0 – potentiometer setting
13	Bypass relay type	0-Electric self holding relay 1-Magnet self holding relay	According to product
14	Phase sequence protection	0 – disabled 1 - enabled	0
15	Bypass mode	0-Send pulse after bypass 1-Stop pulse after bypass	0-Send pulse after bypass
16	Slave Address	1…127	
17	Baud Rate	0-1200 1-2400 2-4800 3-9600 4-19200	3-9600
18	Parity	0-EVEN 1-ODD 2-NONE	0-EVEN

Example 2 :

To Read holding registers at addresses 4 and 5 (O/C protection level, delay) of RVS-AXO # 18, the host computer should send following frame:

byte 1:	Serial Link No.	($12)	
byte 2:	Function	($03)	
byte 3:	Starting Address High	($00)	
byte 4:	Starting Address Low	($04)	
byte 5:	No. of Registers High	($00)	
byte 6:	No. of Registers Low	($02)	
byte 7:	CRC_Low	($XX)	
byte 8:	CRC_High	($XX)	

The RVS-AXO normal response:

byte 1:	Serial Link No.	($12)	
byte 2:	Function	($03)	
byte 3:	Byte Count	($04)	
byte 4:	Data High	($01)	(O/C protection level = 500%)
byte 5:	Data Low	($F4)	
byte 6:	Data High	($00)	(O/C protection delay = 0.1Sec)
byte 7:	Data Low	($01)	
byte 10:	CRC_Low	($XX)	
byte 11:	CRC_High	($XX)	

Example 3:

To set one holding register at address 4 (O/C protection level) to 600 (%FLA) of RVS-AXO # 18, the host computer should send following frame:

byte 1:	Serial Link No.	($12)	
byte 2:	Function	($06)	
byte 3:	Starting Address High	($00)	
byte 4:	Starting Address Low	($04)	
byte 5:	Preset Data High	($02)	(600)
byte 6:	Preset Data Low	($58)	
byte 7:	CRC_Low	($XX)	
byte 8:	CRC_High	($XX)	

The RVS-AXO normal response, is an echo of the query:

byte 1:	Serial Link No.	($12)
byte 2:	Function	($06)
byte 3:	Starting Address High	($00)
byte 4:	Starting Address Low	($04)
byte 5:	Preset Data High	($02)
byte 6:	Preset Data Low	($58)
byte 7:	CRC_Low	($XX)
byte 8:	CRC_High	($XX)

Example 4:

To set two holding registers (O/L protection pickup = 120%, O/L protection grade = 30) of RVS-AXO # 18, the host computer should send following frame:

byte 1:	Serial Link No.	($12)	
byte 2:	Function	($10)	
byte 3:	Starting Address High	($00)	
byte 4:	Starting Address Low	($06)	
byte 5:	No. of Registers High	($00)	
byte 6:	No. of Registers Low	($02)	
byte 7:	Byte Count	($04)	
byte 8:	Data High	($00)	(120)
byte 9:	Data Low	($78)	
byte 10:	Data High	($00)	
byte 11:	Data Low	($03)	
byte 16:	CRC_Low	($XX)	
byte 17:	CRC_High	($XX)	

The RVS-AXO normal response:

byte 1:	Serial Link No.	($12)
byte 2:	Function	($10)
byte 3:	Starting Address High	($00)
byte 4:	Starting Address Low	($06)
byte 5:	No. of Registers High	($00)
byte 6:	No. of Registers Low	($02)
byte 7:	CRC_Low	($XX)
byte 8:	CRC_High	($XX)

DISCRETE COMMANDS (@0…@7 coils)

The RVS-AXO incorporates 8 "Coils", (bit parameters).

Address	Coil	Usage
0	Start / Stop	1 – Start, 0 - Stop
1	Reserved	
2	Reserved	
3	Reserved	
4	Reserved	
5	Reserved	
6	Reserved	
7	Reset	1 – Reset.

Example 5 - Force Single Coil:

To start the motor controlled by RVS-AXO # 18, the host computer should write "1" to the Start / Stop coil.
Note: For Force Single Coil Function, Force Data of $0000 forces "0" = OFF. Force data of $FF00 forces "1" = ON. The "Query" frame sent by the host:

byte 1:	Serial Link No.	($12)	
byte 2:	Function	($05)	
byte 3:	Coil Address High	($00)	
byte 4:	Coils address Low	($00)	
byte 5:	Force Data High	($FF)	(force ON)
byte 6:	Force Data Low	($00)	
byte 7:	CRC_Low	($XX)	
byte 8:	CRC_High	($XX)	

The normal (if no exception) response:

byte 1:	Serial Link No.	($12)
byte 2:	Function	($05)
byte 3:	Coil Address High	($00)
byte 4:	Coils address Low	($01)
byte 5:	Force Data High	($FF)
byte 6:	Force Data Low	($00)
byte 7:	CRC_Low	($XX)
byte 8:	CRC_High	($XX)

DISCRETE HARDWIRED INPUTS Reading

The RVS-AXO incorporates 8 Discrete Inputs, (bit parameters).

Address	Input	Usage
0	Start / Stop	1 – Closed, 0 - Open
1	Reserved	
2	Reserved	
3	Reserved	
4	Reserved	
5	Reserved	
6	Reserved	
7	Reserved	

Example 6:

To read Start / stop input status the host computer should send following Query frame:

byte 1:	Serial Link No.	($12)
byte 2:	Function	($02)
byte 3:	Starting Address High	($00)
byte 4:	Starting Address Low	($00)
byte 5:	No. of Points High	($00)
byte 6:	No. of points Low	($01)
byte 7:	CRC_Low	($XX)
byte 8:	CRC_High	($XX)

The RVS-AXO response, when Start/Stop input is closed:

byte 1:	Serial Link No.	($0C)	(12)
byte 2:	Function	($02)	
byte 3:	Byte Count	($01)	
byte 4:	Data	($01)	(Start / Stop Input is active)
byte 5:	CRC_Low	($XX)	
byte 6:	CRC_High	($XX)	

DIAGNOSTICS

Modbus Function 08, as implemented in the RVS-AXO supports only Sub function $0000. It provides for “loopback" (Return Query Data) feature, for checking the Communication Serial Link between the master and the RVS-AXO.
To request RVS-AXO # 18 to return Query data, the master should send following Query frame:

byte 1:	Serial Link No.	($01)
byte 2:	Function	($08)
byte 3:	Subfunction High	($00)
byte 4:	Subfunction Low	($00)
byte 5:	Data High	($A5)
byte 6:	Data Low	($37)
byte 7:	CRC_Low	($XX)
byte 8:	CRC_High	($XX)

The normal (if no exception) response is the echo of the Query:

byte 1:	Serial Link No.	($12)
byte 2:	Function	($08)
byte 3:	Subfunction High	($00)
byte 4:	Subfunction Low	($00)
byte 5:	Force Data High	($A5)
byte 6:	Force Data Low	($37)
byte 7:	CRC_Low	($XX)
byte 8:	CRC_High	($XX)

EXCEPTION RESPONSES

When the master sends a query frame to a RVS-AXO, one of the following four responses from the RVS-AXO is possible:

1. When no communication error is detected in the query, and no mistake is found by the communication program module in the RVS-AXO, a normal response is returned.

2. If the RVS-AXO does not receive the query frame (for example because of disconnected serial link cable) then no response is returned by the RVS-AXO. After proper time the master will cause a timeout condition.

3. If the RVS-AXO receives the query, but a faulty CRC bytes and / or Parity bits are detected, then no response is returned by the RVS-AXO. After proper time the master will cause a timeout condition.

4. If no communication error is detected in the query, but the RVS-AXO communication program module finds an error such as illegal Function, data address or data value, or if the RVS-AXO is busy, then an Exception response is returned. The Exception response includes Exception Code to inform the master about the type of the error.

Exception Code Response Frame:
Exception response frame holds fix number of 5 bytes. The first one, the Slave Address field is the Serial link number (transmitted in query and identical to RVS-AXO Serial Link No.). The second byte, the Function field returns the echo of the transmitted query function, but with the Most Significant Bit set to 1 (adding $80 to the transmitted function code). The third byte is the Exception Code informing about the type of error. Last two bytes are the CRC bytes.

Exception Codes supported by the RVS-AXO:

Exception Code	Type	Comment
01	Illegal Function	Requested Function is not supported. Functions 1...6, 8, 15 or 16 are supported.
02	Illegal Data Address	Data address is not allowable.
03	Illegal Data Value	Data Value is not in allowable range.
06	RVS-AXO Busy	RVS-AXO is busy now. The master should transmit the message again later.

Example 10:

Master is trying to force coil # 17 of RVS-AXO 32. The RVS-AXO incorporates only 16 coils. Illegal Data Address Exception code will be returned:

Query:

byte 1:	Serial Link No.	($20)	(32)
byte 2:	Function	($05)	
byte 3:	Coil Address High	($00)	
byte 4:	Coils address Low	($11)	(17, Non existent Coil)
byte 5:	Force Data High	($00)	($0000 = "0" = Low)
byte 6:	Force Data Low	($00)	
byte 7:	CRC_Low	($XX)	
byte 8:	CRC_High	($XX)	

Exception response:

byte 1:	Serial Link No.	($20)	
byte 2:	Function	($85)	(Original + $80)
byte 3:	Exception Code	($02)	(Illegal Data Address)
byte 4:	CRC_Low	($XX)	
byte 5:	CRC_High	($XX)	

Note:
There are cases where the RVS-AXO returns Normal response, but the requested action cannot be performed, or is modified by the RVS-AXO. Few examples are:

Requested Action	**Performed Action**
Writing Setting parameters during start process	Ignored.
Writing few parameters (Function 16), some are out of range	Limiting to allowed range.
Start command (Function 05) while Stop Hardwired Input is open	Command ignored

It is the responsibility of the user to verify that the requested action was performed, by reading the value of the modified parameters or the status of the command Coils.