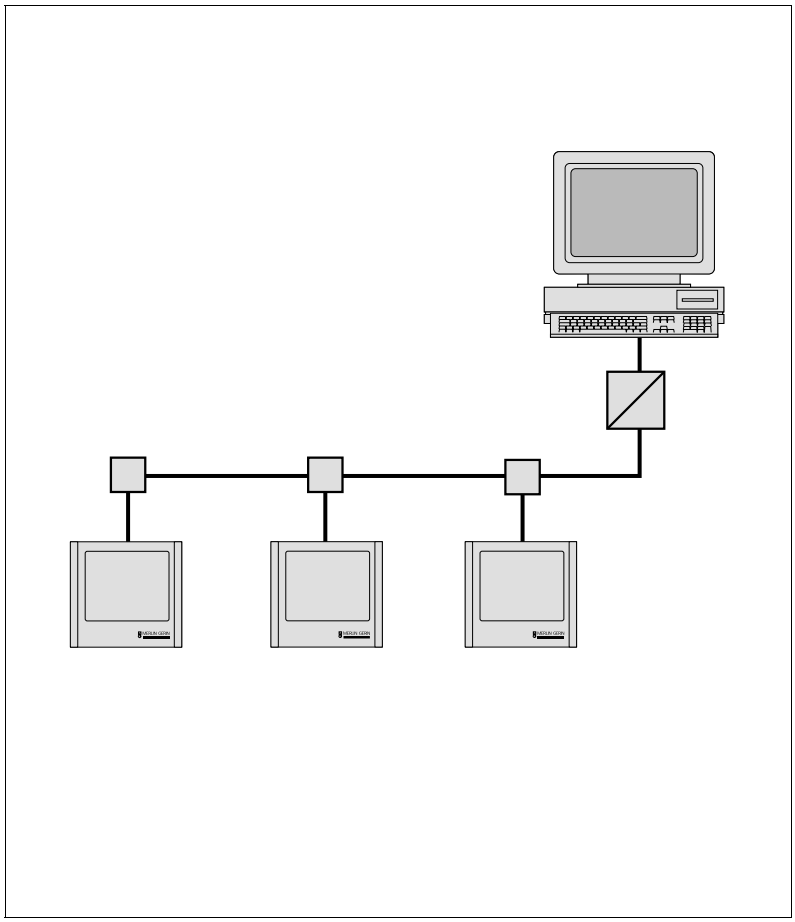
Protection and control

Sepam - RS 485 network connection guide



Merlin Gerin
Modicon
Square D
Telemecanique

Schneider Electric

Introduction

Sepam protection units have an optional communication function.

Sepam 1000+ and Sepam 2000 units may be connected to any 2-wire or 4-wire RS 485 communication network and exchange all the information necessary for centralized control of the electrical installation via a supervisory system, using Modbus master/slave protocol.

To reduce cabling errors, the cause of most problems encountered in the implementation of communication networks, and limit those networks' sensitivity to disturbances relating to the environment, a group of accessories is available to make it easier to connect Sepam units to an RS 485 network.

This manual presents:
- *general characteristics of RS 485 networks*
- *accessories for connecting Sepam units to an RS 485 network*
- *how to associate them, illustrated by a few examples.*

Contents

2-wire RS 485 network

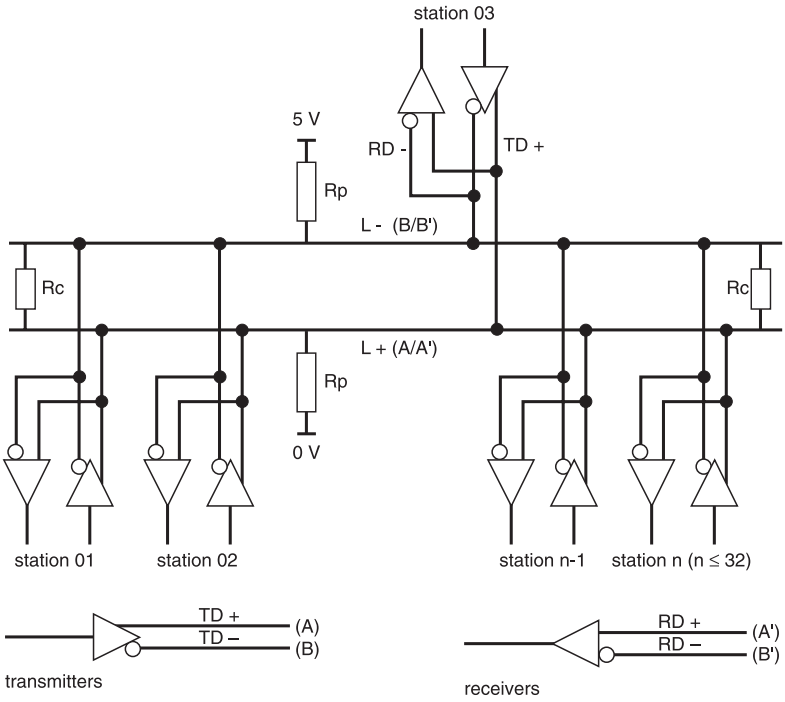
The Sepam 1000+ and Sepam 2000 communication architecture complies with the OSI (Open Systems Interconnect) model proposed by the International Standardization Organization (ISO).
The physical transmission of data signals complies with the EIA RS 485 standard (differential voltage transmission mode).
An RS 485 network may be cabled according to two different principles:
- *2-wire RS 485 network*
- 4-wire RS 485 network.

Two-wire cabling of the communication network makes it possible to use a single shielded pair, which means simple cabling.
Each item of equipment connected to the network includes a transmitter and a receiver that are connected to the same cable.
Since communication is half duplex, alternating and two-way, messages are conveyed in both directions on the same line from the master to the slaves and vice versa.
Communication takes place alternately, with the transmitters taking turns on the line.
The master can be any station.

Connection of the stations

The network comprises a single cable (a shielded, twisted pair). The various stations in the network are connected by linking both of the following:
- all the outputs marked + (TD+, RD+) to the network + wire (marked L+)
- all the outputs marked - (TD-, RD-) to the network - wire (marked L-).

General architecture of a 2-wire RS 485 network



Line-end impedance matching

Two 150 Ω resistors (Rc) are required (one at each end) to match line impedance.
Each item of equipment, as well as each connector, connection box or Sepam interface, contains a 150 Ω resistor which can be used for this purpose.

Polarization of the RS 485 network

Polarization creates a continuous flow of current through the network, putting all the receivers in deactivated status until a transmitter is validated.
The network is polarized by connecting the (L+) line to the 0 V and the (L-) line to the 5 V via two 470 Ω polarization resistors (RP).
The network should only be polarized in one location on the line to avoid random transmission.
It is recommended that the master's power supplies and resistors be used.
The ACE 909-2 and ACE 919 converters provide this polarization.
Some Schneider equipment offers also this possibility.

Please note:
Some equipment items do not comply with the RS 485 standard with respect to polarities as well as polarization and line impedance matching.
When a mixture of equipment is being connected, make sure to check these points.

4-wire RS 485 network

For 4-wire connection of the communication network, 2 shielded pairs are used.
With 4-wire connection, the “master station” is defined and then the two communication lines, a master to slaves “transmission” line and a slaves to master “receiving” line.
Communication is alternating half duplex. Requests are sent from the master to the salves on the transmission line. Replies are sent from the slaves to the master on the receiving line.

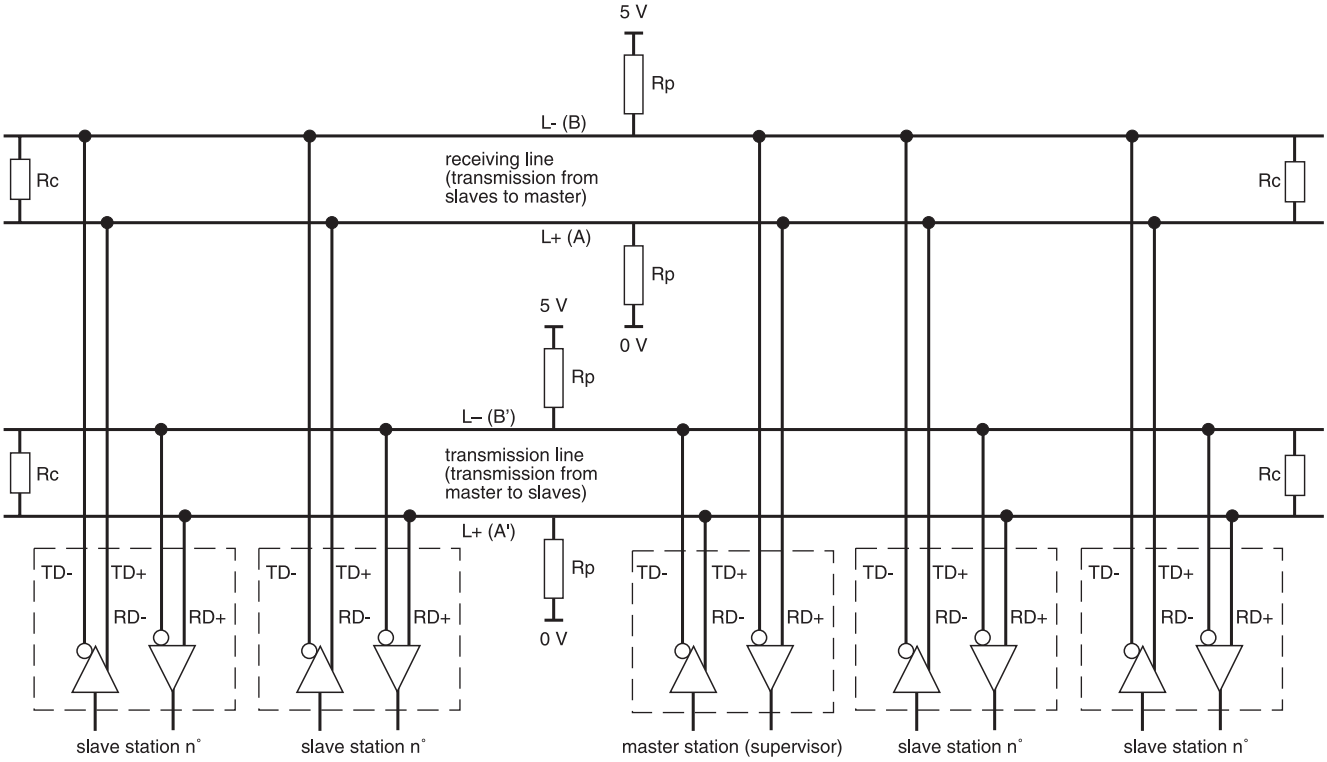
Connection of slave stations

The different network are stations are connection by linking:
- RD+ inputs to the L+ “transmission” line (A’)
- RD- inputs to the L- “transmission” line (B’)
- TD+ outputs to the L+ “receiving” line (A)
- TD- outputs to the L- “receiving” line (B).

Connection of the master station

The connection of the master station is the opposite of that of the slave stations:
- RD+ input to the L+ “receiving” line (A)
- RD- input to the L- “receiving” line (B)
- TD+ output to the L+ “transmission” line (A’)
- TD- output to the L- “transmission” line(B’).

General architecture of a 4-wire RS 485 network



Rc = load resistor (150 ohms)

Rp = polarization resistor (470 ohms)

Line-end impedance matching

Four 150 Ohm resistors (Rc) are mandatory (one at each end) for impedance matching of both the transmission and receiving lines.

Polarization of the RS 485 network

It is necessary to polarize both the transmission and receiving lines.
Polarization of the transmission and receiving lines is not ensured by the Sepam interfaces.

Characteristics of Sepam communication interfaces

	Sepam 1000+	Sepam 2000
Type of transmission	Asynchronous serial	Asynchronous serial
Protocol	Modbus / Jbus slave	Modbus / Jbus slave
Rate	4800, 9600, 19200, 38400 bauds	300, 600, 1200, 2400, 4800, 9600, 19200, 38400 bauds
Frame format	11 bits (1 start, 8 bits, 1 parity, 1 stop)	11 bits (1 start, 8 bits, 1 parity, 1 stop)
Parity bit setup	No parity check Even parity Odd parity	No parity check Even parity Odd parity
Maximum number of slaves on a Modbus RS 485 network	25	32
RS 485 electrical interface	ACE949-2, compliant with the EIA 2-wire differential RS 485 standard ACE959, compliant with the EIA 4-wire differential RS 485 standard	Communication coupler board compliant with the EIA 2-wire or 4-wire differential RS 485 standard
Communication interface supply	External, by 12 Vdc or 24 Vdc auxiliary supply	By Sepam 2000
Branch length	3 m maximum	3 m maximum
Maximum length of RS 485 network with standard cable	With 12 Vdc bus-supplied interfaces: *(1)* 320 m with 5 Sepam 1000+ 180 m with 10 Sepam 1000+ 160 m with 20 Sepam 1000+ 125 m with 25 Sepam 1000+ With interfaces with 24 Vdc bus-supplied interfaces: *(1)* 1000 m with 5 Sepam 1000+ 750 m with 10 Sepam 1000+ 450 m with 20 Sepam 1000+ 375 m with 25 Sepam 1000+	1300 m

(1) lengths multiplied by 3 with a high-performance FILEA cable with a maximum of 1300 m.

Characteristics of converters

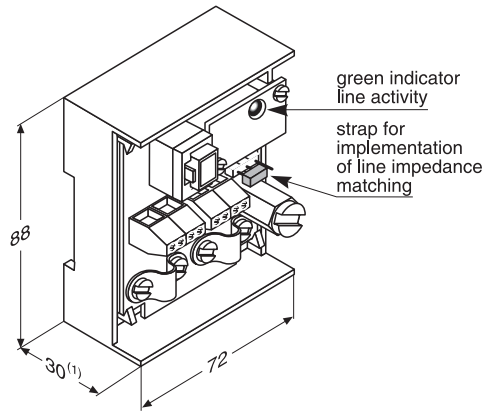
	ACE909-2	ACE919 AC	ACE919 DC
Converter supply voltage	110 Vac or 220 Vac	110 Vac or 220 Vac	24 Vdc or 48 Vdc
Converter	RS 232 / 2-wire RS 485	2-wire RS 485 / 2-wire RS 485	2-wire RS 485 / 2-wire RS 485
Auxiliary supply for Sepam 1000+ interfaces	12 Vdc	12 Vdc	12 Vdc

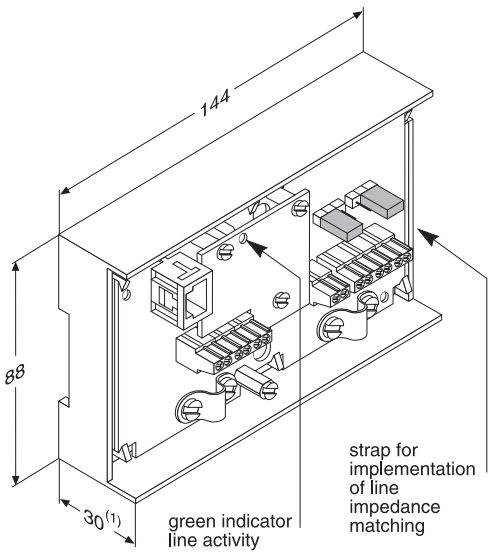
Interfaces and accessory selection guide

Type of network	Sepam 1000+	Sepam 2000 with communication option
2-wire RS 485		CCA609 or CCA629 connection box and CCA602 cable or CCA619 connector
2-wire RS 485 + external 12 V DC or 24 V DC supply (12 Vdc supply provided by ACE909-2 or ACE919 2 wire RS 485 converters)	ACE949-2 interface and CCA612 cable	CCA629 connection box (ensures continuity of 12 Vdc or 24 Vdc supply) and CCA602
4-wire RS 485		CCA609 connection box and CA602 cable
4-wire RS 485 + external 12 V DC or 24 Vdc supply	ACE949-2 interface and CCA612 cable	CCA609 connection box (does not ensure continuity of 12 V DC or 24 V DC supply) and CCA602 cable

N.B. *All Merlin Gerin equipment with the same type of RS 485 interface as the Sepam 2000 may be connected to an RS 485 network using the Sepam 2000 connection accessories.*

2 modules may be used for simple, dependable implementation of the Sepam 1000+ communication option:
- *ACE949-2: communication interface for 2-wire RS 485 network*
- *ACE959: communication interface for 4-wire RS 485 network.*

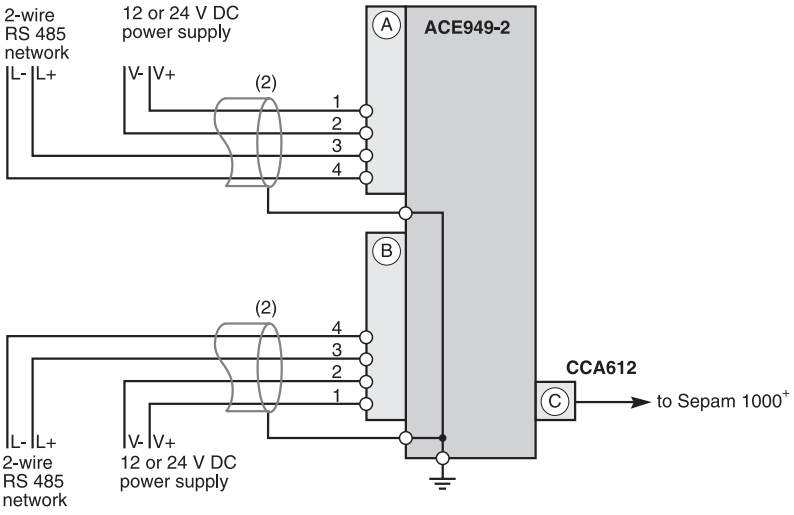




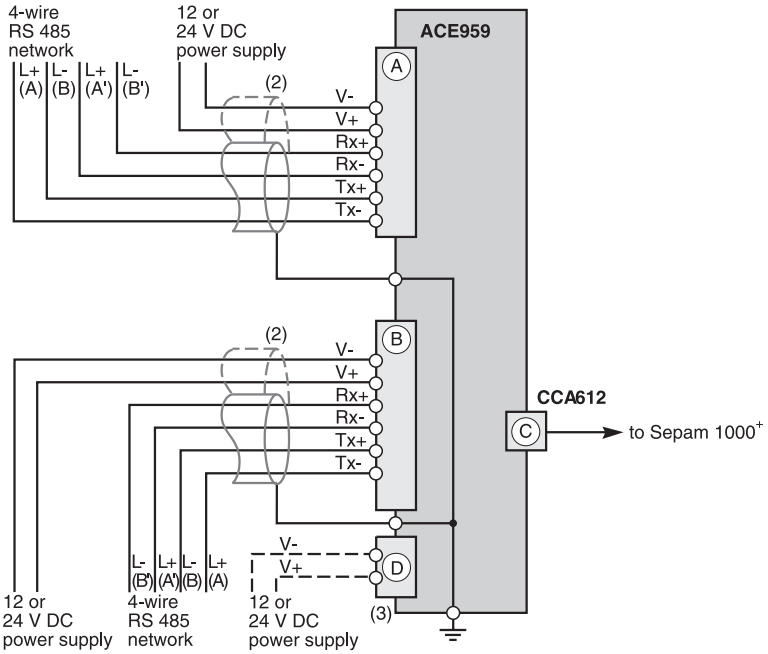
The ACE949-2 and ACE959 remote modules are connected to the C connector of the Sepam 1000+ base unit using the CCA612 prefabricated cable (L = 3 m). They are to be supplied by an external 12 Vdc or 24 Vdc ±10%, 500 mA supply. The 12 Vdc supply may be provided by the ACE909-2 or ACE919 converters.

N.B. *The ACE949-2 interface replaces the ACE949 interface.*

ACE949-2 : interface for 2-wire RS 485 network



ACE959 : interface for 4-wire RS 485 network



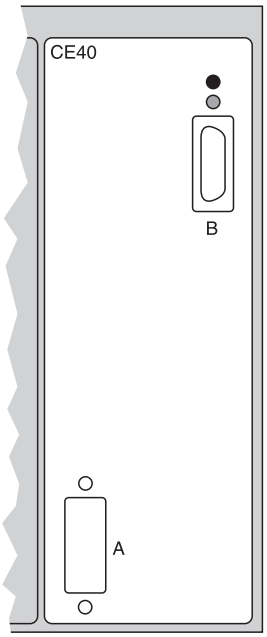
Rx+, Rx-: Sepam receiving (eq IN+, IN-)
Tx+, Tx-: Sepam transmitting (eq OUT+, OUT-)

(1) depth with CCA77x connection cord: 70 mm.
(2) distributed power supply with separate cabling or included in the shielded cable (3 pairs).
(3) terminal block for connection of the module providing the distributed power supply.

On Sepam 2000, the communication function is performed by an optional RS 485 communication coupler board, mounted on the CE40 supply board.

Sepam 2000 communication interface

Rear view of the CE40 board with communication coupler installed.

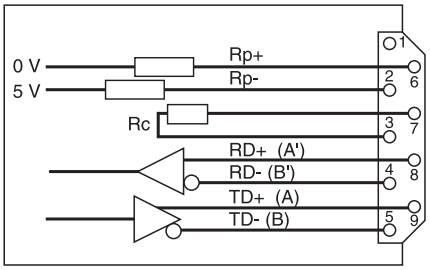


signal lamps
steady red: coupler fault or coupler initializing
flashing green: communication active
(transmission or receiving in progress)

communication connector
9-pin Sub-D communication socket connector
(item B)

Sepam 2000 auxiliary
supply connector
(item A)

Diagram of the communication coupler board
for 2-wire or 4-wire RS 485 networks

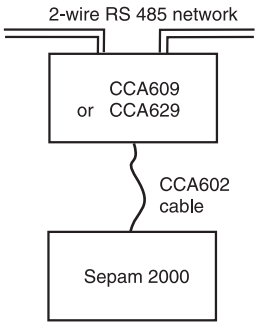


Rc = load resistor

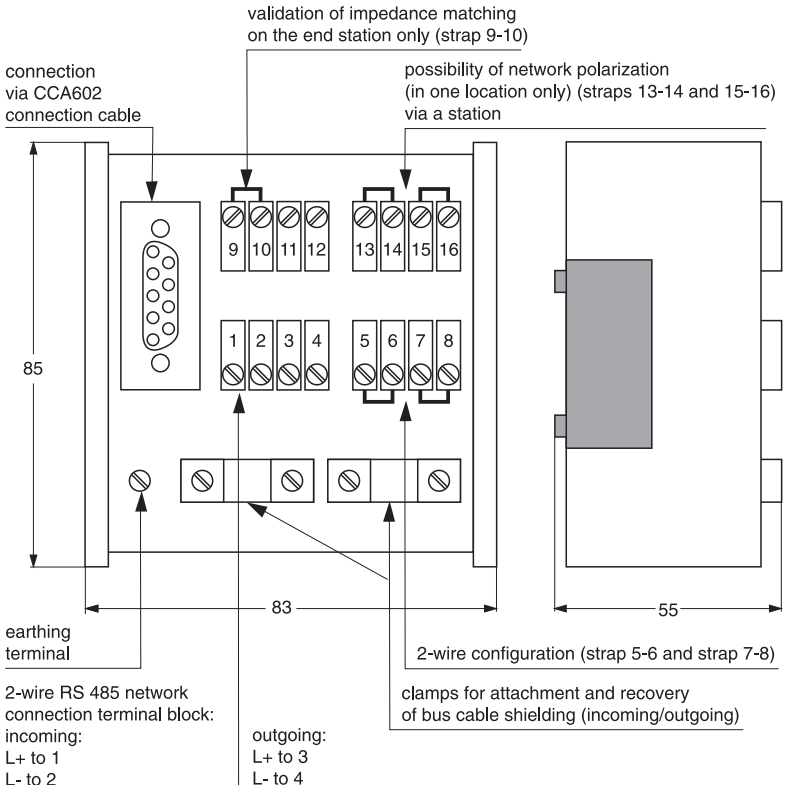
Rp = polarization resistor

Sepam 2000 connexion box

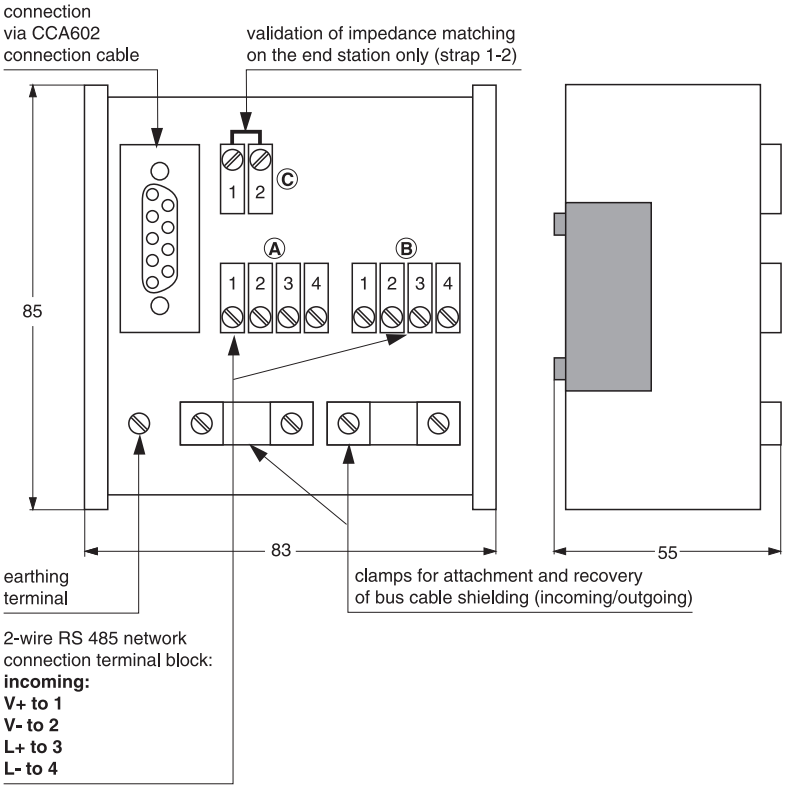
Two connection boxes may be used to connect the Sepam 2000 communication interface to an RS 485 network:
■ *CCA609 connection box:*
□ *branching of a 2-wire or 4-wire RS 485 network*
□ *polarization of the RS 485 network by Sepam 2000*
■ *CCA629 connection box:*
□ *branching of a 2-wire RS 485 network only*
□ *continuity of distributed power supply necessary for Sepam 1000+ communication interfaces.*
These two connection boxes are connected to the Sepam 2000 by a CCA602 prefabricated cable (L = 3 m).
They facilitate the connection of new stations later on and make it possible to remove a station from the network without leaving any connectors "loose".



CCA609: 2-wire or 4-wire RS 485 connection box



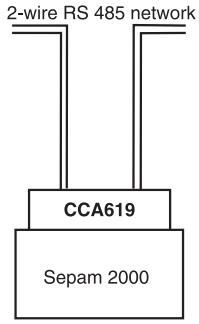
CCA629: 2-wire RS 485 connection box



Mechanical characteristics

- mounting on symmetrical/asymmetrical DIN rail
- dimensions: 83 mm (L) x 85 mm (H) x 110 mm (D) with CCA602 connected
- weight: 120 g.

Sepam 2000 connexion box

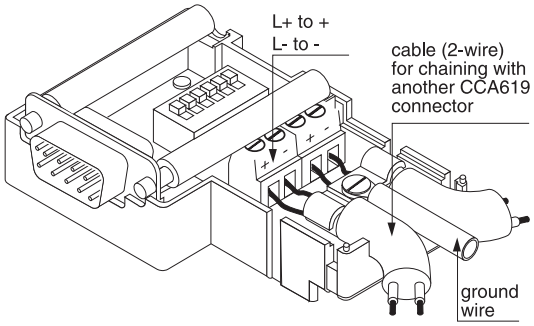


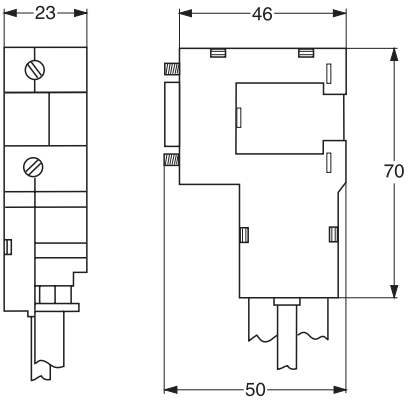
CCA619: 2-wire RS 485 connector

Each equipment item may be connected directly to a 2-wire RS 485 network via a CCA619 connector.

- dimensions: 23 mm (L) x 70 mm (H) x 50 mm (D)
- weight: 120 g.

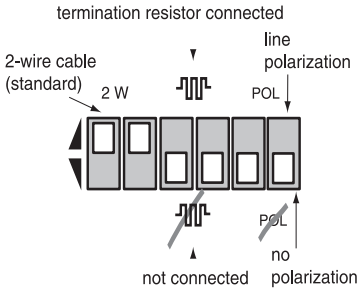
Connection of the CCA619 connector



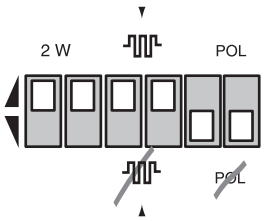


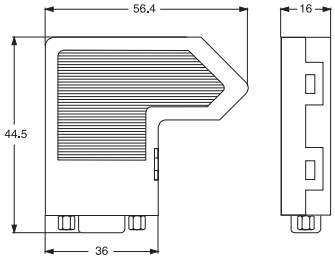
Setting of the configuration microswitches

CCA619 is not at the end of the line:



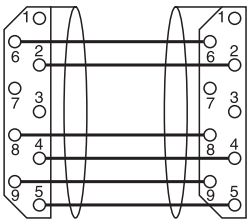
CCA619 is at the end of the line:





CCA600: 9-pin plug

The CCA600 connector may be used to make a cable of the appropriate length.
A connector is supplied with the ACE909-2 and ACE919.



CCA602: branching cable

The CCA602 cable is used to create branches of the RS 485 network from the CCA609 or CCA629 connection box to each equipment item.
It may also be used to connect the ACE909-2 converter (master / central computer link).
This 3-meter cable comprises 9-pin sub-D connector with a metallic cover at either end.

RS 485 network cable

The RS 485 network cable needed to interconnect CCA connection boxes or ACE type interfaces should have the following characteristics:
- twisted pair with tinned copper braid shielding, coverage: > 65%
- resistance per unit length: < 100 Ω / km
- gauge: AWG 24
- characteristic impedance: 120 Ω
- capacitance between conductors: < 60 pF / m
- conductor and shielding: < 100 pF / m.

The total network cable length should not be greater than **1300 meters** except limitation due to distributed power supply.

Examples of compatible standard cables:
- supplier: BELDEN
  - single-pair cable, reference 9841
  - 2-pair cable, reference 9842
- supplier: FILOTEX 2-pair cable, reference FMA-2PS.

High-performance cables recommended for the connection of Sepam 1000+:
- cables with a pair dedicated to distributed power supply
  - resistance per unit length < 34 Ω per km
  - AWG 20 gauge
- and 1 (or 2) pair(s) dedicated to the 2-wire or 4-wire RS 485 network
  - resistance per unit length: < 58 Ω / km
  - 1 supply pair (red-black)
  - AWG 22 gauge
- supplier: FILECA
  - 2-pair cable, reference F2644-1
(1 red-black supply pair, 1 white-blue RS 485 pair)
(cable distributed by Schneider Electric in 60 m strands, reference CCR301)
  - 3-pair cable, reference F3644-1
(1 red-black supply pair, 2 white-blue and yellow-brown RS 485 pairs).

Wiring precautions

For the sake of both the safety of people and efficient combating against the effects of interference, the cabling of systems which comprise digital links must comply with a set of basic rules aimed at establishing an equipotential-bonded, meshed and earthed network.

Special care must be taken when making connections between buildings with earthing that is not interconnected.
For details and useful recommendations, please refer to the Schneider document DBTP 542 entitled “Modbus network guide”.
All the accessories make it possible to ensure the continuity of the cable shielding and regular grounding.
It is therefore necessary to ensure that:
- the 2 connectors at the ends of the CCA 602 branching cable are plugged in correctly and locked by the 2 screws specially provided
- the clamps are tightened onto the metallic shielding braid on each CCA609, CCA619, CCA629, ACE949-2, ACE959 connection box
- each CCA connection box is grounded (earthed) by a 2.5 mm2 diameter green-yellow wire or a short braid (< 10 cm) via the terminal specially provided
- the metal case of the ACE909-2, ACE919 converter is grounded (earthed) by a green-yellow mains power supply connector wire and an eye lug on the back of the case.

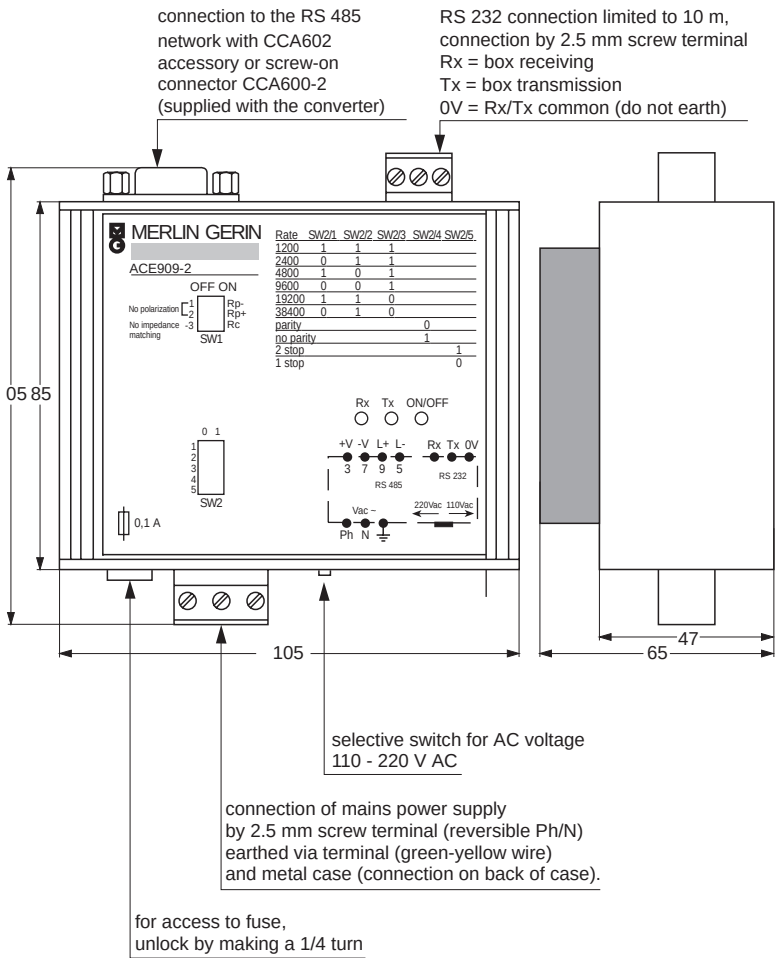
ACE909-2 converters

The converter ACE909-2 equipped with a V24/RS 232 type port as a standard feature to stations cabled to a 2-wire RS 485 network.
Without requiring any flow control signals, after the parameters are set, the ACE909-2 converter performs the following, after parameter setting: conversion, network polarization and automatic dispatching of Modbus frames between the master and the stations by half-duplex, single-pair transmission.

The ACE909-2 converter also provides a 12 V DC supply for the distributed power supply of the Sepam 1000+ ACE949 / ACE949-2 / ACE959 interfaces.
The setting of the communication parameters should be the same as the setting of the Sepam units and the master communication.

ACE909-2: 2-wire RS 232 / RS 485 converter and 12 V DC power supply

Connections



Data displayed on the front of the device

- ON/OFF: On (lit) / Off (extinguished)
- Tx, Rx display of RS 232 transmission and receiving line activity.

Electrical characteristics

- mains power supply:
  - 110 Vac / 220 Vac, ±10%, 47 to 63 Hz
- protection by 0.1 A time-delayed fuse (5 mm x 20 mm)
- galvanic isolation 2000+ V rms, 50 Hz, 1 mn between:
  - mains input and interface internal power supply outputs
  - mains input and mechanical frame
- galvanic isolation 1000 V rms, 50 Hz, 1 mn between RS 232 and RS 485 interfaces
- transmission delay < 100 ns.

Mechanical characteristics

- mounting on symmetrical/asymmetrical DIN rail
- dimensions: 105 mm (L) x 85 mm (H) x 47 mm (D)
- weight: 460 g
- b ambient operating temperature: -5 °C to +55 °C.

Electromagnetic compatibility	
CEI 60255-5, 1.2 impulse wave, 50 µs	1 kV differential mode 3 kV common mode
CEI 60255-22-1, 1 MHz damped oscill. wave	0,5 kV defferential mode 1 kV common mode
CEI 60255-22-4, 5 ns fast transients	4 kV with capacitive coupling in common mode 2 kV with direct coupling in common mode 1 kV with direct coupling in differential mode

N.B. *the ACE909-2 replaces the ACE909.*

Parameter setting of supply voltage

The 110 Vac/220 Vac supply voltage is changed using a selector switch which may be accessed on the bottom of the box (fuse end).

Please note:
This operation must be performed before energizing the converter.

Parameter setting of communication via SW2

Used to set the rate and format of asynchronous transmission.
To change the parameter setting, the box must be de-energized in order for the new values to be processed.
The communication parameters should be the same as those of:

- the RS 232 master (central computer)
- the RS 485 slaves (Sepam).

The Sepam frame format (11 bits, 1 start, 8 bits, 1 parity, 1 stop) requires the following parameters:

- SW2/4 = 0 with parity check
- SW2/5 = 1 stop bit.

Speed	SW2 / 1	SW2 / 2	SW2 / 3
1200	1	1	1
2400	0	1	1
4800	1	0	1
9600	0	0	1
19200	1	1	0
38400	0	1	0

Strap	Position	Function
SW2 / 4	0	with parity check
	1	without parity check
SW2 / 5	1	2 stop bits
	0	1 stop bit

Parameter setting of line resistors via SW1

The SW1 microswitches are used to activate (or deactivate) the RS 485 network polarization and line impedance matching resistors.

Strap	Position	Function
SW1 / 1	ON	polarization at 0 V via Rp - 470 Ω
SW1 / 2	ON	polarization at 5 V via Rp + 470 Ω
SW1 / 3	ON	150 Ω impedance matching resistor at end of RS 485 bus

Box configuration when delivered

- mains power supply 220 Vac
- 9600 baud rate, 8-bit format, with parity, 1 stop bit
- polarization and line impedance matching resistors activated.

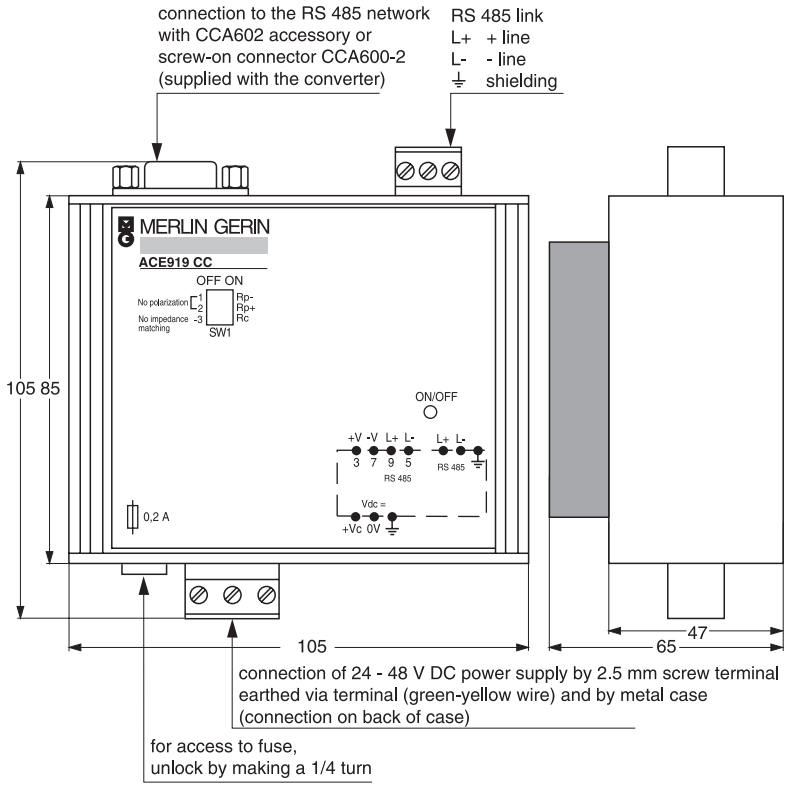
The ACE 919 converters is used to connect a master / central computer equipped with an RS 485 type port as a standard feature to stations cabled to a 2-wire RS 485 network.

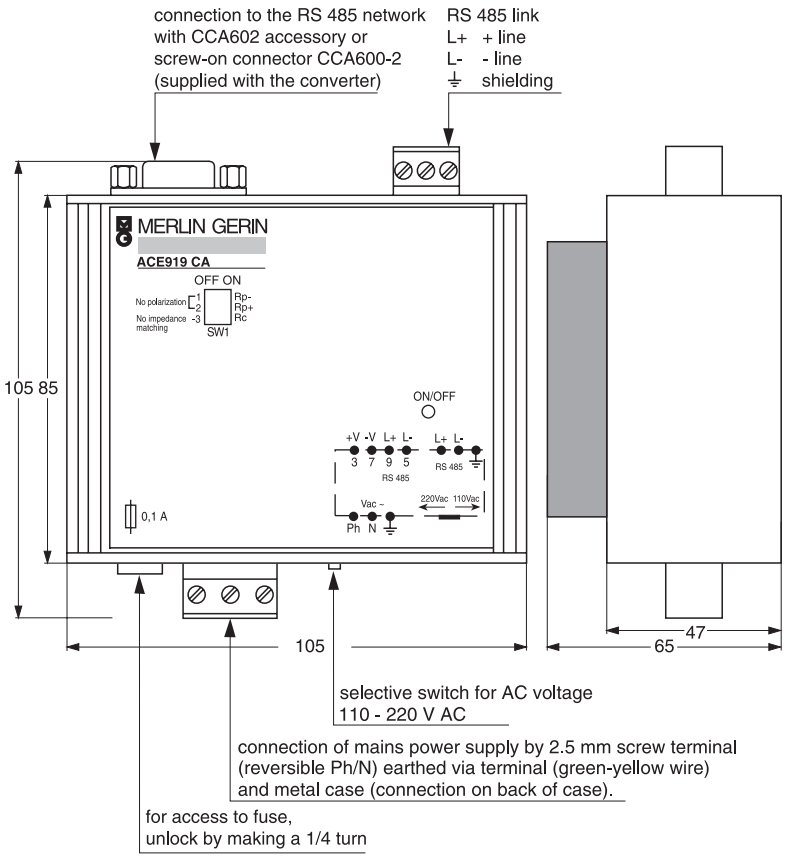
Without requiring any flow control signals, the ACE919 converters ensure network polarization and line-end impedance matching.
The ACE909 converters also provide a 12 V DC supply for the distributed power supply of the Sepam 1000+ ACE949 / ACE949-2 / ACE959 interfaces.

There are two ACE919 converters:
- *ACE919 CC, DC supplied*
- *ACE919 AC, AC supplied.*

ACE919: 2-wire RS 485 / 2-wire RS 485 converters and 12 Vdc supply

Connections





Data displayed on the front of the device
- On/Off: On (lit) / Off (extinguished).

Electromagnetic compatibility	
CEI 60255-5, 1.2 impulse wave, 50 ms	1 kV differential mode 3 kV common mode
CEI 60255-22-1, 1 MHz damped oscill. wave	0,5 kV defferential mode 1 kV common mode
CEI 60255-22-4, 5 ns fast transients	4 kV with capacitive coupling in common mode 2 kV with direct coupling in common mode 1 kV with direct coupling in differential mode

Electrical characteristics

ACE919 CC:

- ■ DC power supply
- □ 24 / 48 Vdc, ±20 %
- ■ galvanic isolation 2000+ V rms, 50 Hz, 1 mn between:
- □ mains input and interface internal power supply outputs
- □ mains input and mechanical frame.

ACE919 AC:

- ■ mains power supply
- □ 110 Vac / 220 Vac, ±10%, 47 to 63 Hz
- □ protection by 0.1 A time-delayed fuse (5 mm x 20 mm).

Mechanical characteristics

- ■ mounting on symmetrical/asymmetrical DIN rail
- ■ dimension, 105 mm (L) x 85 mm (H) x 47 mm (D)
- ■ weight: : about 460 g
- ■ ambient operating temperature: -5 °C to +55 °C.

Parameter setting of supply voltage on ACE919 AC

For ACE 919 CA the 110 Vac/220 Vac supply voltage is changed using a selector switch which may be accessed on the bottom of the box (fuse end).

Please note:
This operation must be performed before energizing the converter.

Parameter setting of line resistors via SW1

The SW1 microswitches are used to activate (or deactivate) the RS 485 network polarization and line impedance matching resistors.

Strap	Position	Function
SW1 / 1	ON	polarization at 0 V via Rp - 470 Ω
SW1 / 2	ON	polarization at 5 V via Rp + 470 Ω
SW1 / 3	ON	150 Ω impedance matching resistor at end of RS 485 bus

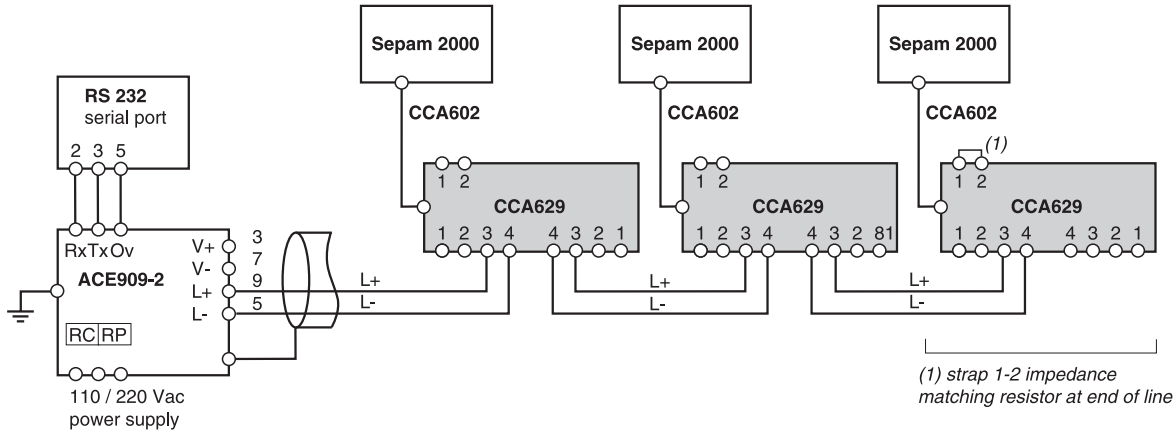
Box configuration when delivered

- ■ mains power supply 220 Vac
- ■ polarization and line impedance matching resistors activated.

Connection of Sepam 2000 to a 2-wire RS 485 network

RS 232 master with ACE909-2

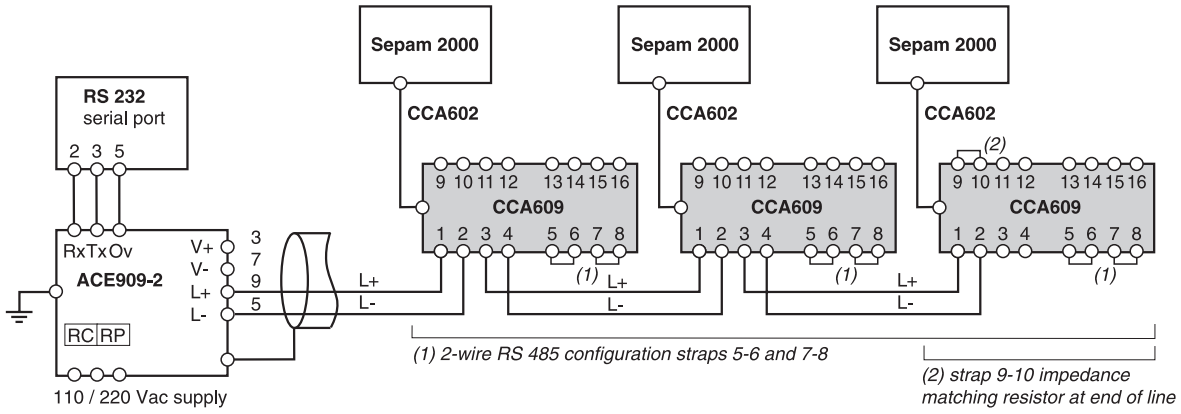
Sepam 2000 units connected by CCA629 and CCA602



Rc = load resistor

Rp = polarization resistor

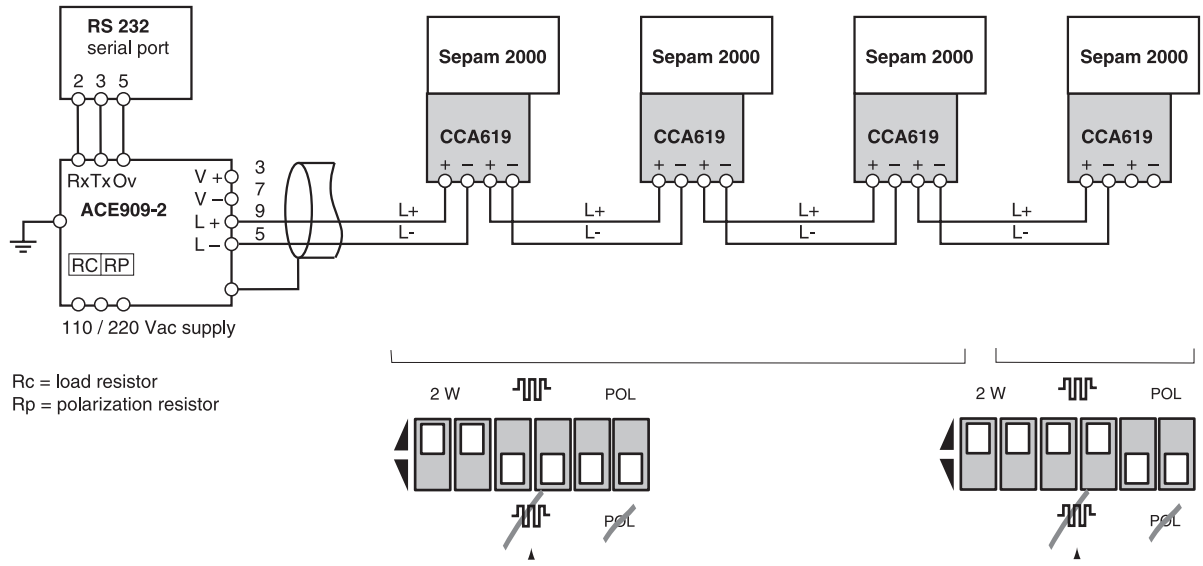
Sepam 2000 units connected by CCA609 and CCA602



Rc = load resistor

Rp = polarization resistor

Sepam 2000 units connected by CCA619

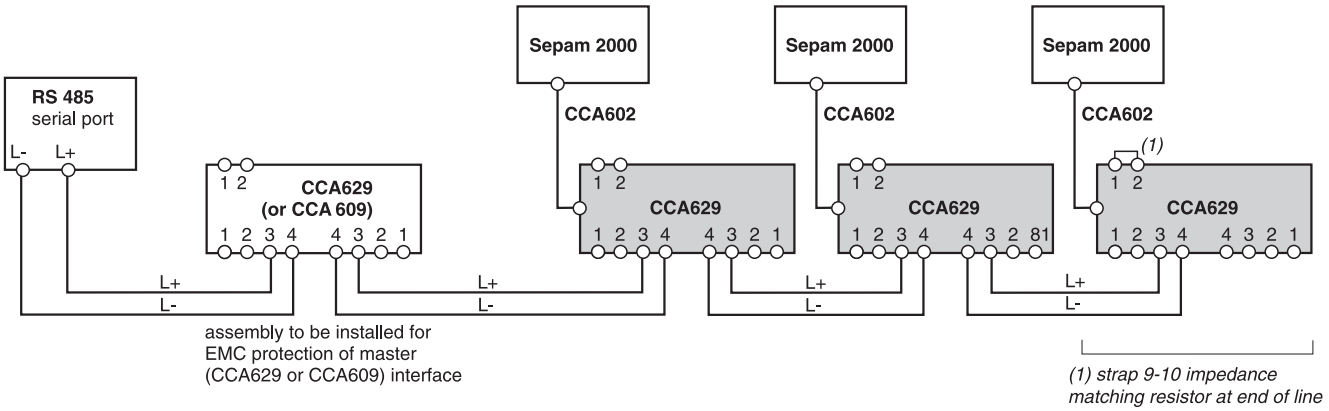


Rc = load resistor
Rp = polarization resistor

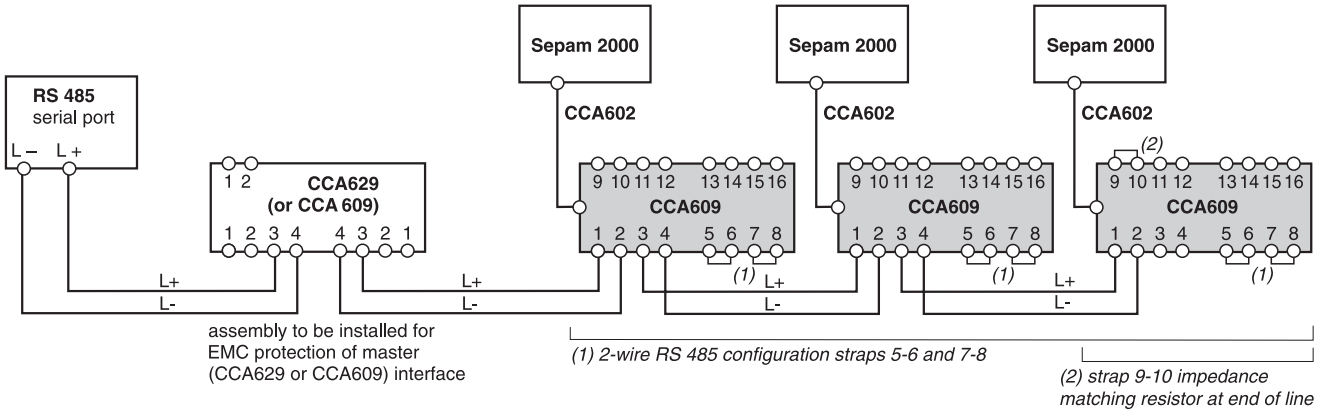
Connection of Sepam 2000 to a 2-wire RS 485 network

RS 485 master without converter

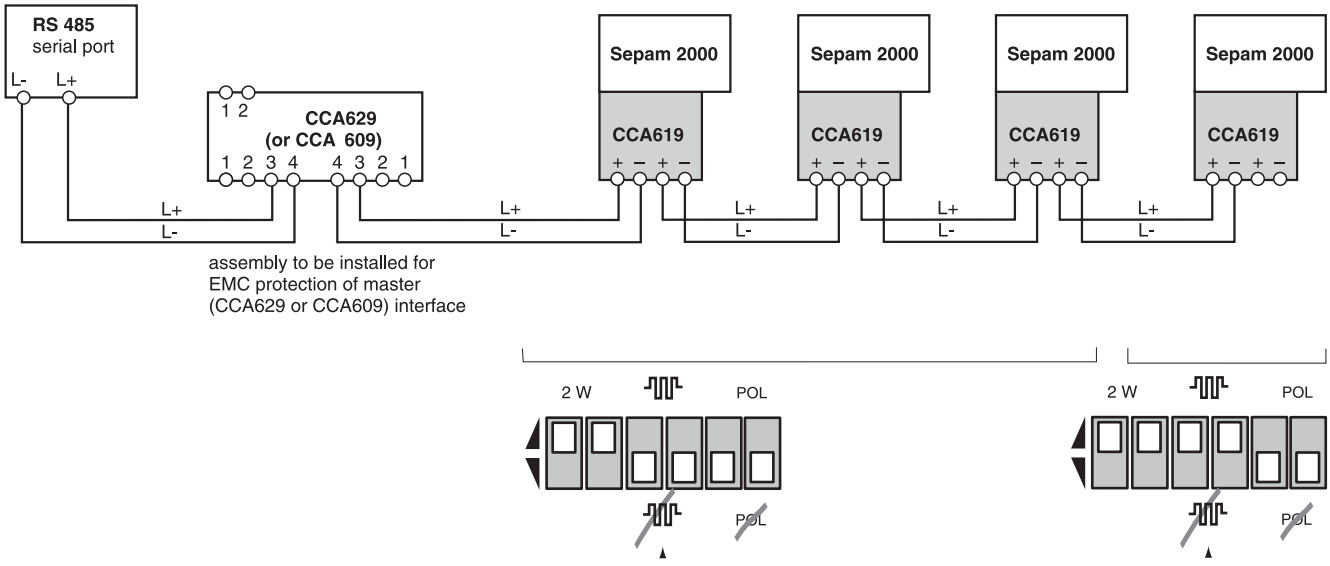
Sepam 2000 units connected by CCA629 and CCA602



Sepam 2000 units connected by CCA609 and CCA602



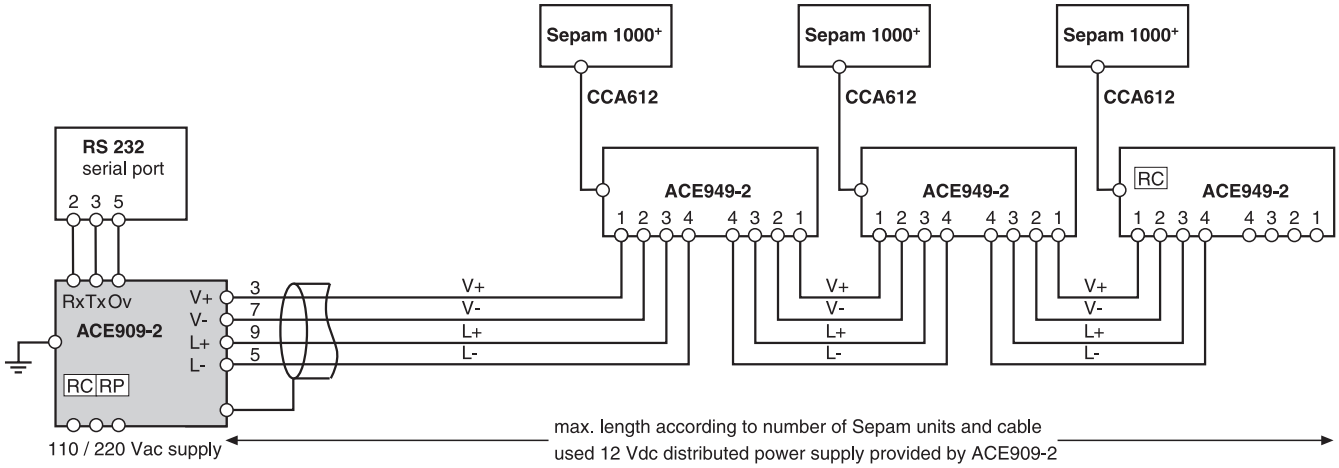
Sepam 2000 units connected by CCA619



Connection of Sepam 1000+ to a 2-wire RS 485 network

RS 232 master with ACE909-2

Sepam 1000+ units connected by ACE949-2 and CCA612

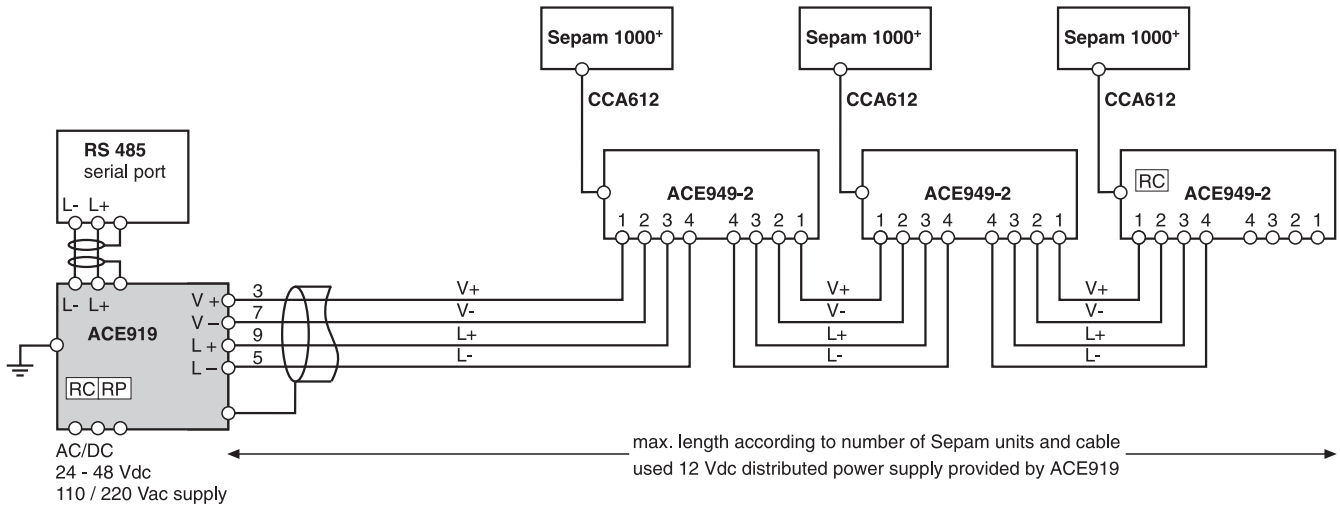


RC impedance matching resistor to be installed if at end of line

RP polarization of desactivated line

RS 485 master with ACE919

Sepam 1000+ units connected by ACE949-2 and CCA612



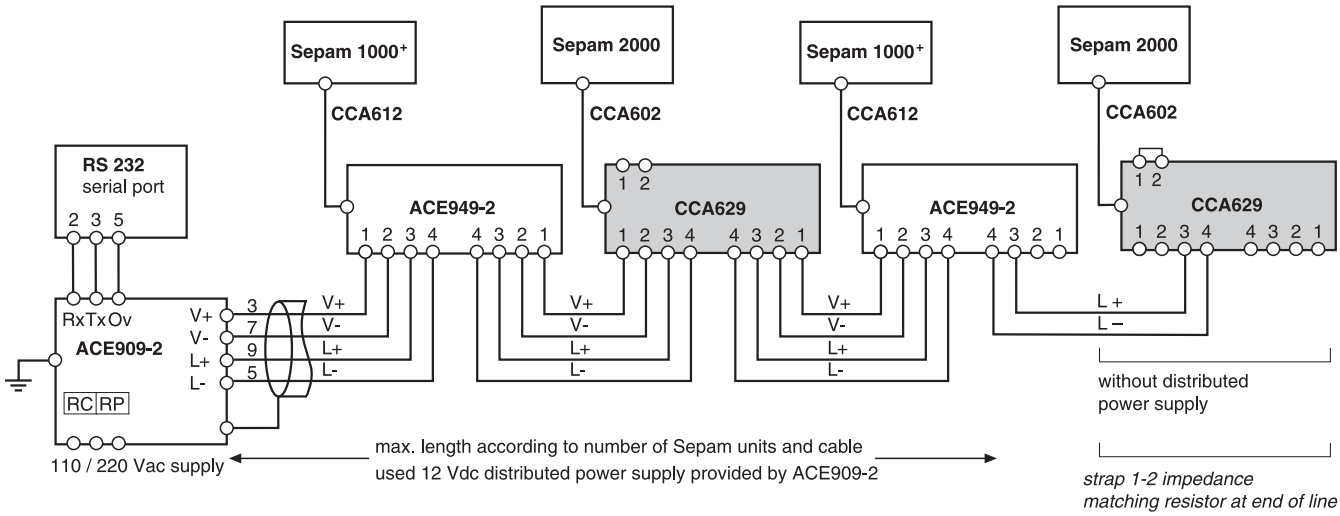
RC impedance matching resistor to be installed if at end of line

RP polarization of desactivated line

Connection of Sepam 1000+ and Sepam 2000 to a 2-wire RS 485 network

RS 232 master and Sepam 1000+ / Sepam 2000

Sepam 2000 units connected by CCA629 to ensure continuity of distributed power supply necessary for ACE949-2

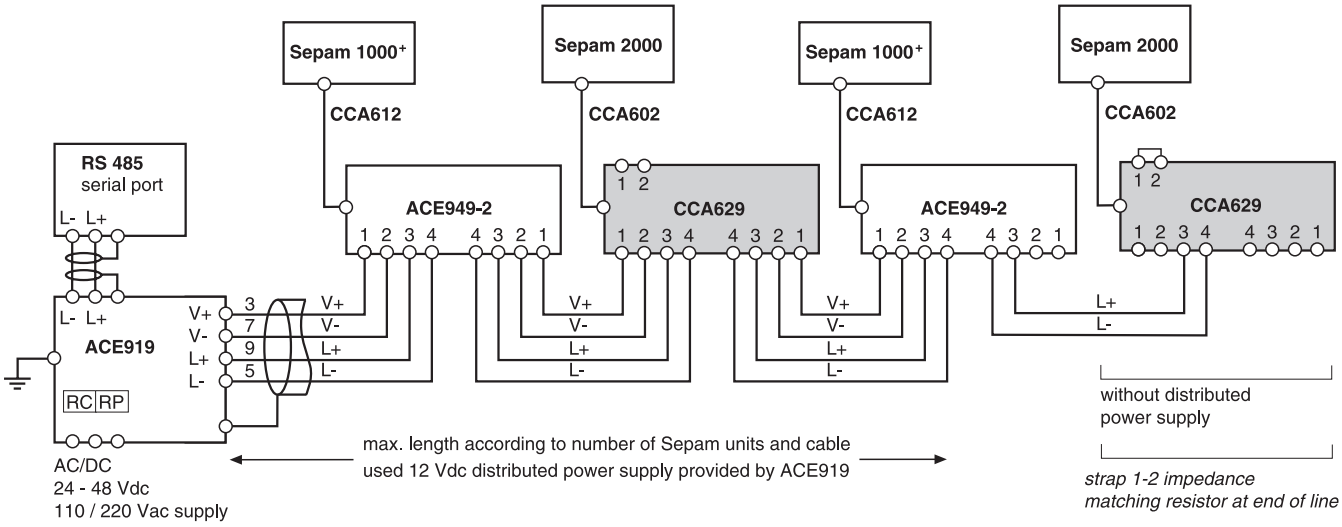


RC impedance matching resistor to be installed if at end of line

RP polarization of desactivated line

26-wire RS 485 and Sepam 1000+ / Sepam 2000

Sepam 2000 units connected by CCA629 to ensure continuity of distributed power supply necessary for ACE949-2



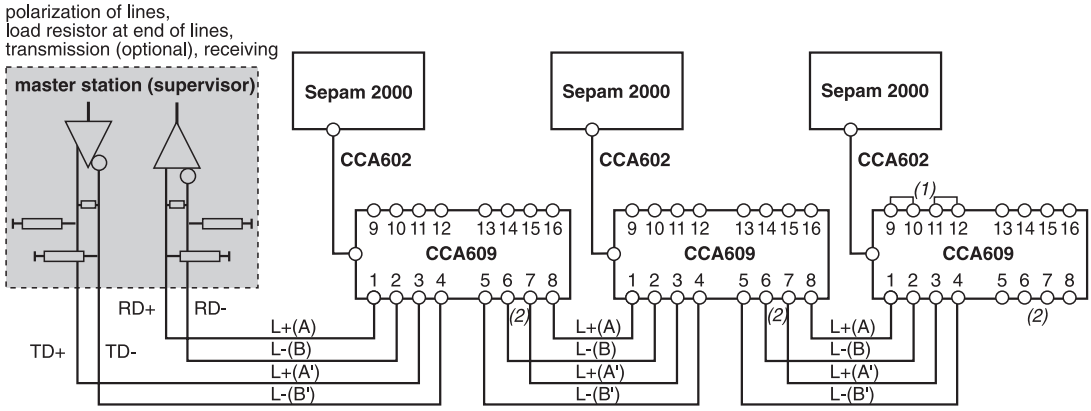
RC impedance matching resistor to be installed if at end of line

RP polarization of desactivated line

Connection of Sepam 1000+ and Sepam 2000 to a 4-wire RS 485 network

4-wire RS 485 master and Sepam 2000

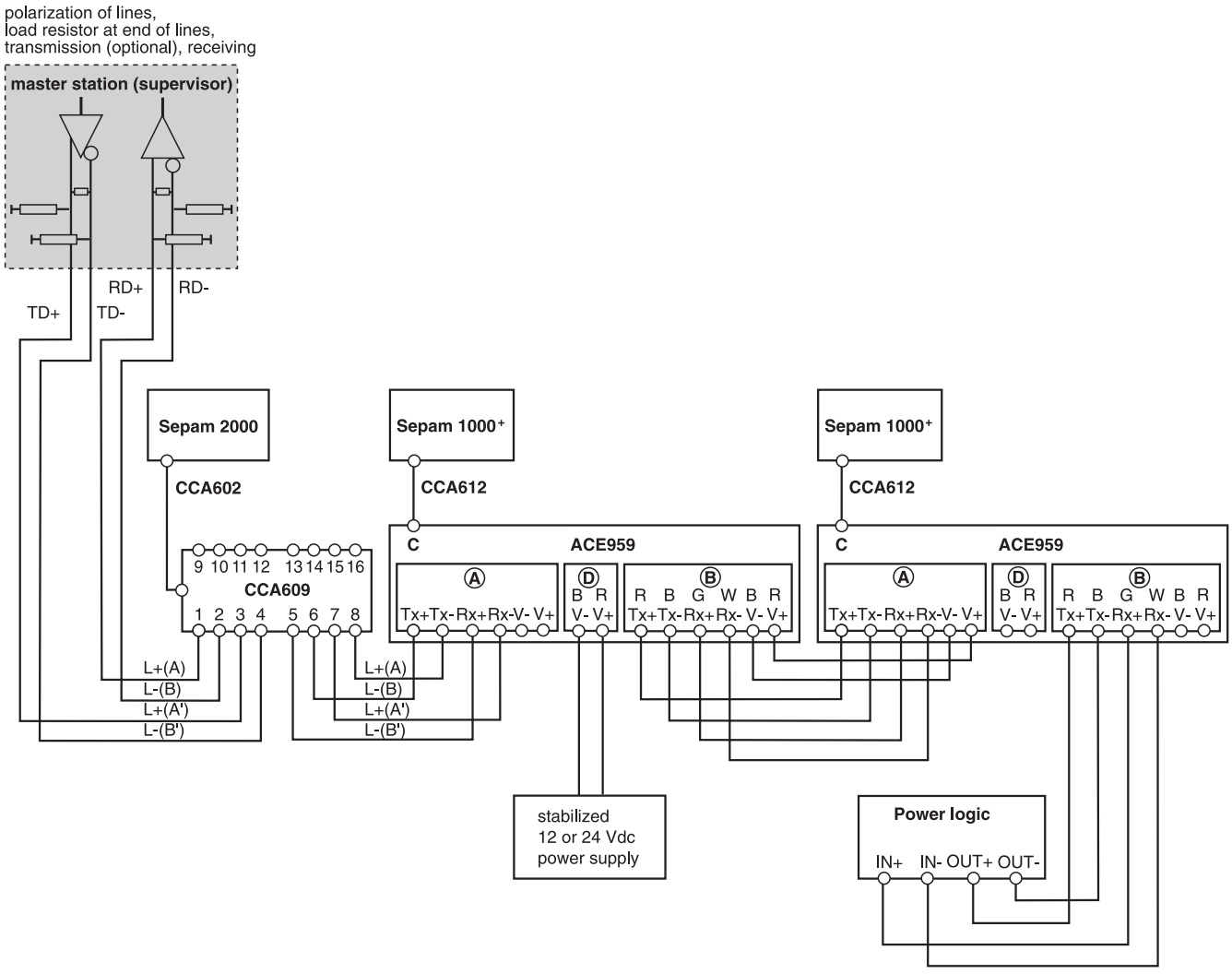
Master station at line end



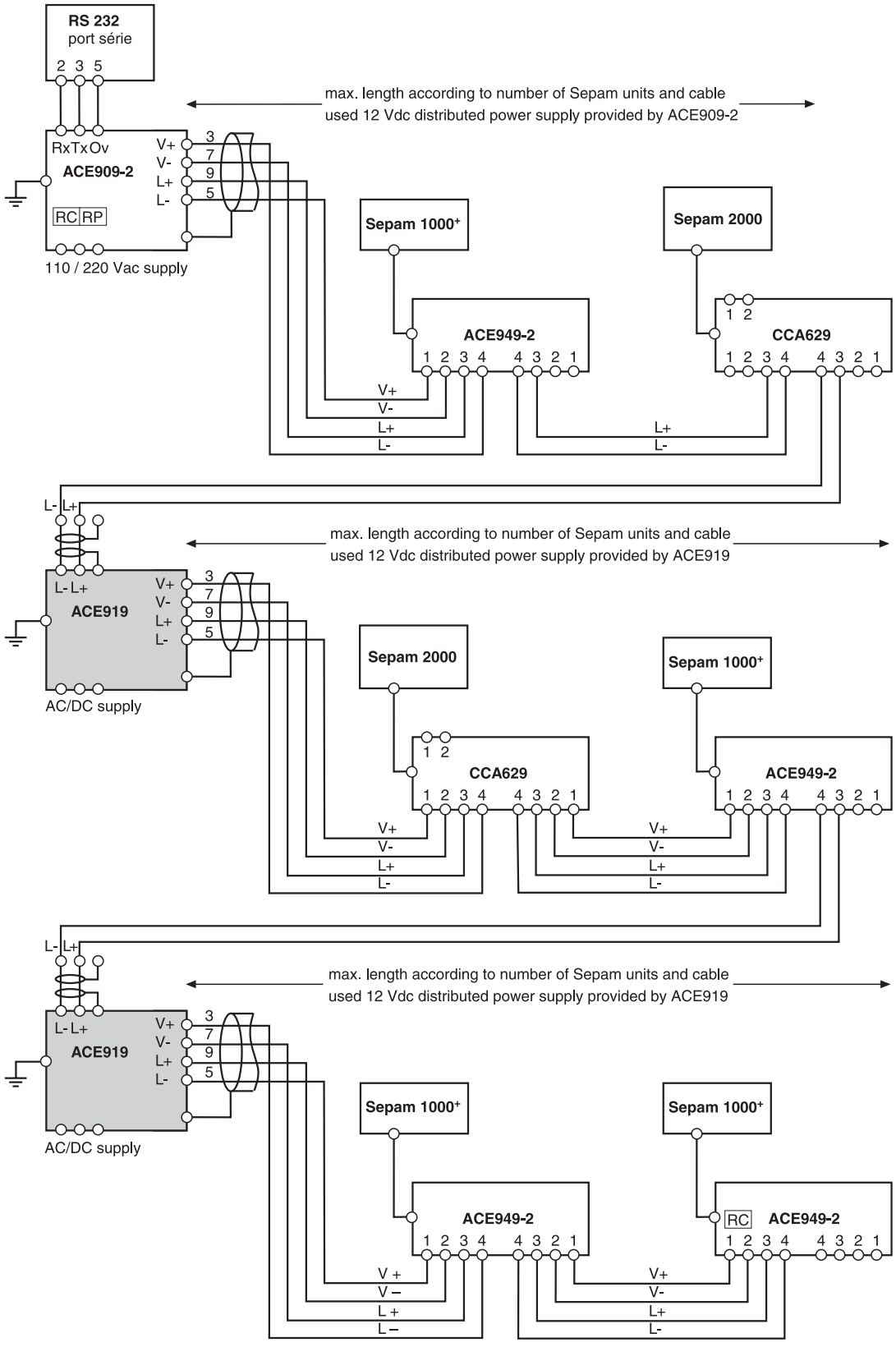
(1) strap 9-10 and 11-12 impedance matching resistor at end of both lines
(2) removal of strap 5-6 and 7-8 in 4-wire RS 485 configuration

4-wire RS 485 master and Sepam 1000+ / Sepam 2000

Master station at line end



2-wire RS 485 network extension with ACE919



RC impedance matching resistor to be installed if at end of line

RP polarization of desactivated line

Setting of communication parameters

Before Modbus communicatioln equipment is put into service, parameters need to be set.

Selection	
transmission rate adjustable from 300 to 38 400 bauds	on converters on equipment
slave n° assigned adjustable from 1 to 255	on equipment
parity: no parity, even parity, odd parity	on converters on equipment
line polarization	1 location only (master)
line impedance matching	at end of line on converters on equipment

Troubleshooting

Operating problems

it is advisable to connect the devices to the RS 485 network one by one.
The green lamp indicates that there is traffic on the line.
Make sure that the master sends frames to the equipment concerned and to the RS 232 - RS 485 / RS 485 - RS 485 converter, if there is.

Points to be checked

Check:

- the wiring to the CCA612 connectors, the CCA602 branching cables and the RS 485 network cable
- the wiring of the ACE convecters
- the wiring to each CCA629, CCA609 and CCA619 connection box
- the wiring of the ACE949-2 or ACE959 interface
- the distributed voltage V+, V- (12 Vdc)
- the polarization is in one location only
- the impedance matching is set up at the ends and only at the ends of the RS 485 network
- the cable used is the one advised
- the ACE converters used are correctly connected and parameterized
- the L+ or L- lines are not earthed
- the earthing of all the cable shielding
- the earthing of all the converters, interfaces and connection boxes.

Use an oscilloscope to check the forum of the signals:

- transmit voltage
  - level 0 +1,5 V to +5 V
  - level 1 -1,5 V à -5 V
- reception voltage threshold
  - level 0 > +0,2 V
  - level 1 < -0,2 V.

Notes

Notes

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As standards, specifications and designs change from time to time, please ask for confirmation of the information given in this publication.

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