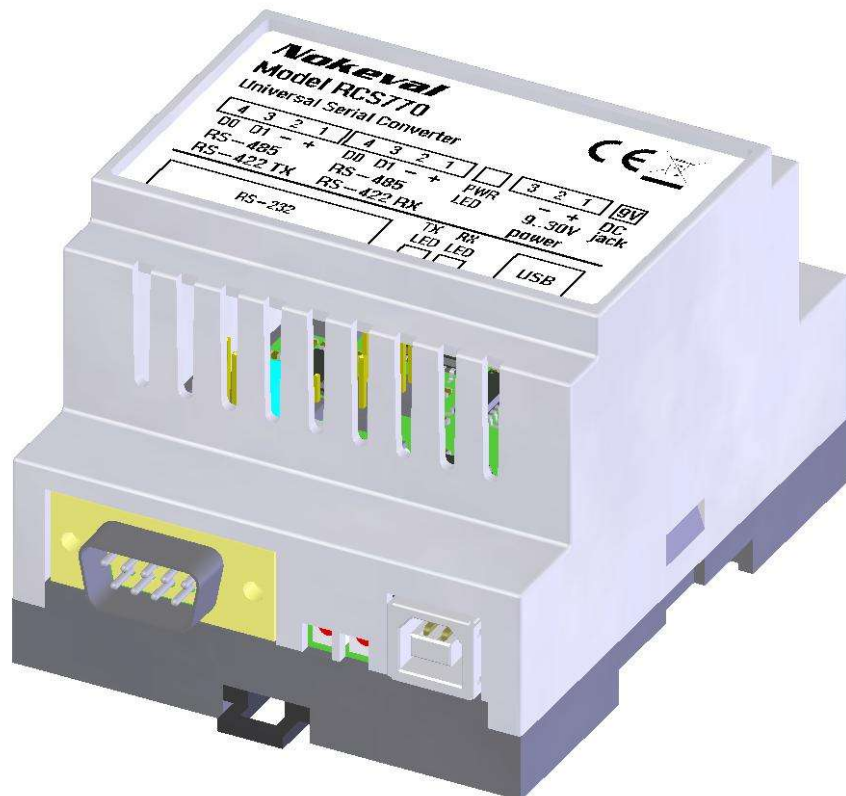# User Manual

23.5.2006

V1.0

RCS770
USB / RS-485 / RS-232 converter

Nokeval

INTRODUCTION

RCS770 is a general-purpose serial converter equipped with a USB port, RS-232 port and two RS-485 ports. Conversion can be done in all directions. Alternatively, this converter can act as a RS-485 repeater allowing more RS-485 devices to be used, since one bus can normally hold 32 devices. The two RS-485 ports can be configured to act as a single full-duplex RS-422 port or a four-wire RS-485 port.

USB, RS-232 and RS-485 sections are galvanically isolated from each other, which will eliminate ground loops and give more tolerance against disturbances and overvoltages. However, the two RS-485 buses are not isolated from each other.

If RCS770 is connected to a computer via USB, it creates a virtual serial port that can be used just like an ordinary port. Every converter has an individual serial number, and the converter will retain the same COM port number even if plugged into a different USB port on the same computer. This increases reliability.

RCS770 is able to pass various serial protocols, including Nokeval SCL, Modbus ASCII, Modbus RTU, and HART. The RS-485 direction is changed automatically, no handshake lines are required.

RS-485 bus is attached via screw terminals, avoiding the need to make solder joints on field.

SPECIFICATIONS

USB port

Version:	USB 1.1 or 2.0
Interface chip:	FTDI FT232R
Power consumption:	< 200 mA
Connector:	USB-B (A-B cable included)

RS-485 ports

Baud rates	300…230400 bit/s, except as a repeater 1200…115200.
Data bits	5…8
Parity	All supported
Stop bits	1, 1.5 or 2 on USB, 1 on RS-232
Bus length	1000 m max
Devices on bus	max 32 standard devices or 128 1/4 load devices
Load	1/4 load (128 devices of this kind can exist on the same bus)
Transmitter enable	Automatic

RS-232 port

Connector:	D9 male (DTE) (null modem cable for PC included)
Baud rates:	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200
Handshake lines:	Not controllable, linked internally

External power supply

Note: external power supply is not necessary when the USB is used.

Voltage:	8…28 VDC
Current:	<200 mA

General

Dimensions:	70x85x60 mm + connectors
Oper. temperature:	-30...60 °C
Galvanic isolation:	Yes, 2kV AC/DC

EMC

EMC immunity	EN 61326
EMC emissions	EN 61326 class B

CONVERSION MODE

The conversion mode and other settings are done with jumpers. To access them, the enclosure has to be opened. Insert a small flat blade screwdriver between the lid and the bottom part of the enclosure left or right side and pull the lid off.

The converter is factory pre-set as a USB–485 converter, all baud rates allowed. RS-485 buses are terminated and have fail-safes on.

Every conversion mode has a page of its own. After these, there are some pages about installing the USB drivers and other additional information.

Connectors

| Conn	Purpose
J3	RS-485 bus 2, or RS-422 bus Tx
J4	RS-485 bus 1, or RS-422 bus Rx
J8	An external power supply can be connected here, see page 10
J7	An external power supply can be connected here
J6	RS-232 port
J2	USB port

Indicators

LED	Purpose
D1	This converter is powered up. USB drivers are working.
D2	This converter is receiving data from PC via USB
D3	This converter is sending data to PC via USB

Jumpers

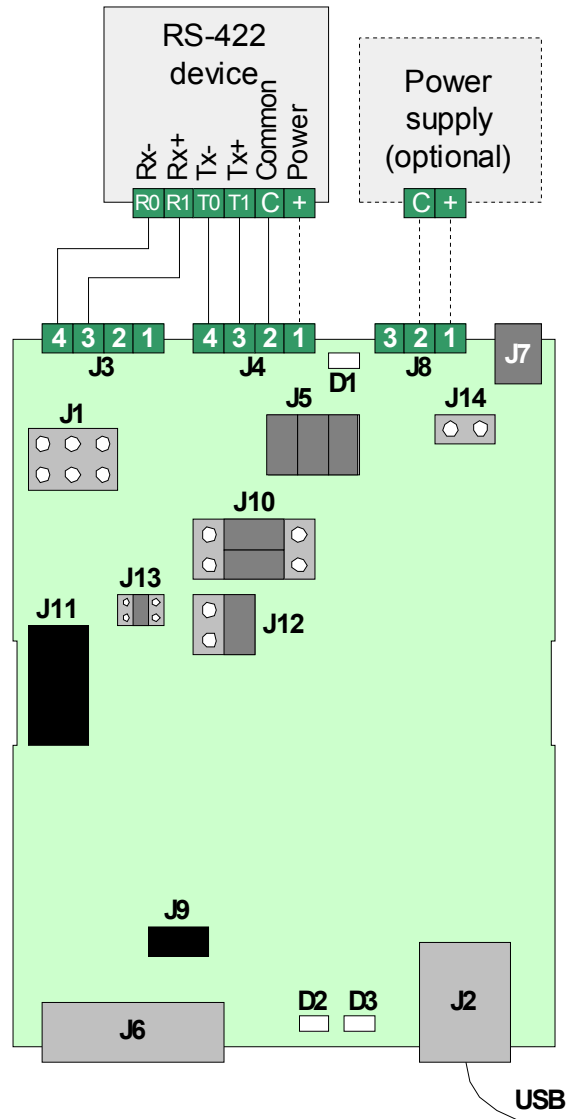| Jumper	Purpose
J1	RS-485 bus 2 termination and fail-safe
J5	RS-485 bus 1 termination and fail-safe
J14	Connects the power supply of the bus devices and this converter together, see page 10.
J11	Baud rate and bit format selection. Not used when USB is used.
J13	Programming connector for the microcontroller. The middle pins must be jumped.
J10 and J12	Conversion mode. Modes are explained on the following pages.
J9	Closed when 485–485 repeater, open otherwise.
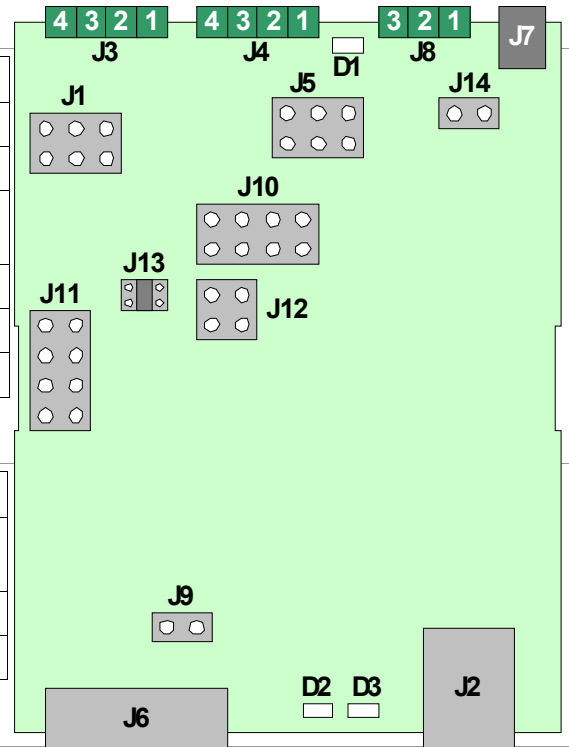
USB — RS-485
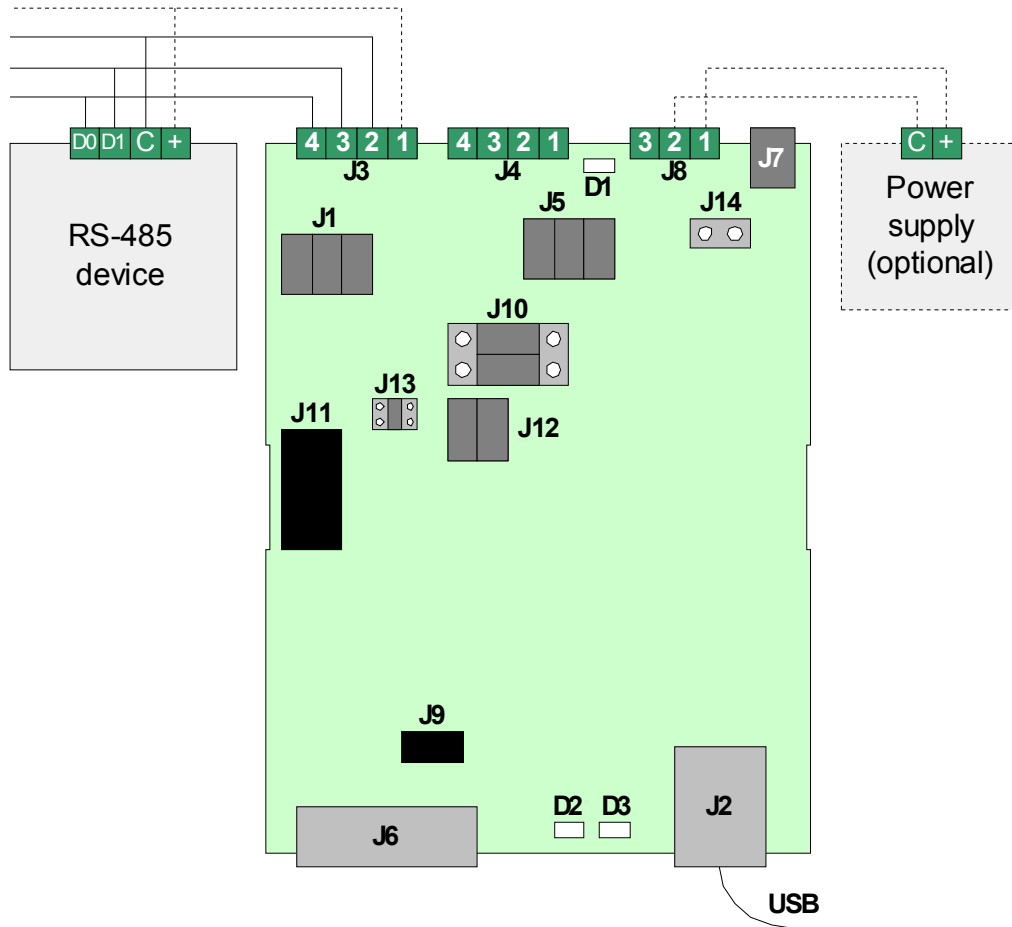
Jumpers

- To set in USB – RS-485 mode, set J10 and J12 according to the picture.
- J1 and J5 define the 485 bus termination, see page 12.
- J14 controls the power supply options, see page 10.
- J11 and J9 are not used.

Connections

- USB is connected to a computer. See page 11 on drivers.
- RS-485 buses J3 are J4 equal. Any or both of them may be used. See page 12.
- No external power supply is required, but J8 can be used to power up the RS-485 devices connected in connectors J3 and J4. The power supply is routed from J8 to J3 terminal 1 and J4 terminal 1.

USB – RS-422

RS-422 device

Rx- Rx+ Tx- Tx+ Common Power

| R0 | R1 | T0 | T1 | C | + |

Power supply (optional)

| C | + |

| 4 | 3 | 2 | 1 |
J3

| 4 | 3 | 2 | 1 |
J4

D1

| 3 | 2 | 1 |
J8

J7

J1

J5

J14
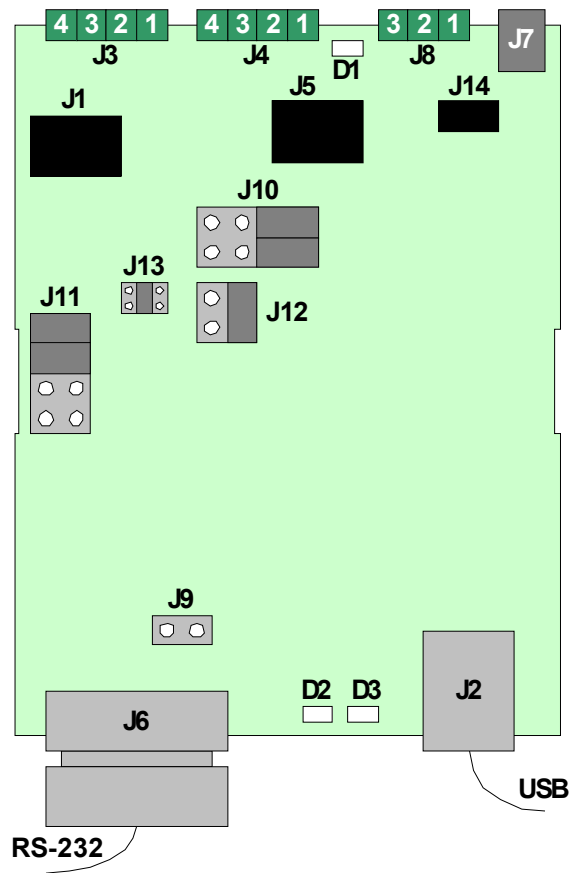
J10

J13

J11

J12

J9

J6

D2   D3

J2

USB

Jumpers

- Set J10 and J12 according to the picture.
- J1 and J5 define the 485 bus termination, see page 12.
- J14 controls the power supply options, see page 10.
- J11 and J9 are not used.

Connections

- USB is connected to a computer. See page 11 on drivers.
- J3 and J4 are the RS-422 bus. This device transmits at J3 and receives at J4.
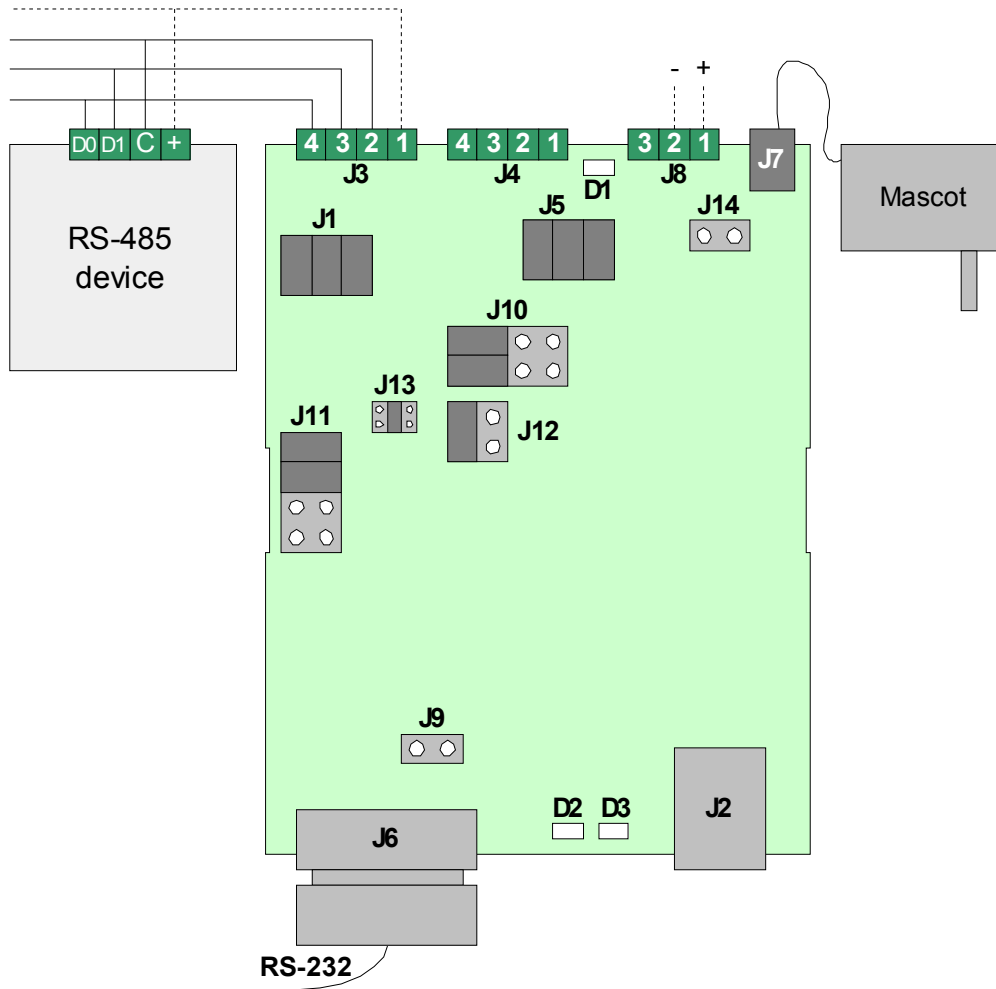- No external power supply is required.

USB – RS-232

Jumpers

- The USB–232 mode is selected with jumpers J9, J10, and J12 according to the picture.
- J1, J5, J11, and J14 have no effect.
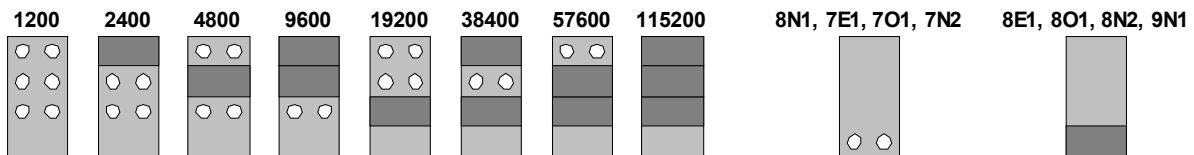
Connections

- USB is connected to a computer. See page 11 on drivers.
- How to use the RS-232 bus, see page 15.
- No external power supply is needed.
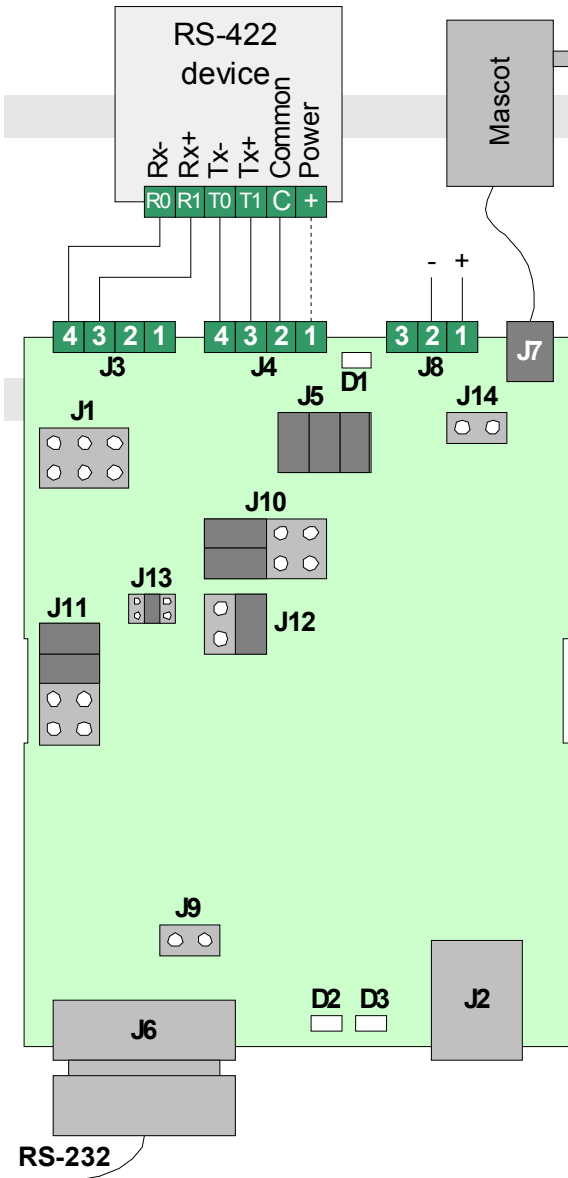
RS-232 — RS-485

Jumpers

- To select 232–485 mode, set jumpers J9, J10, and J12 according to the picture.
- J1 and J5 select the 485 bus terminations, see page 12.
- J14 controls the power supply flow onto the bus, see page 10.
- J11 is used to control the baud rate and bit format:

Connections

- RS-485 buses J3 and J4 are equal. Any or both of them may be used. See page 12.
- RS-232 bus is explained on page 15.
- This converter must be powered externally on J7 or J8, see page 10.
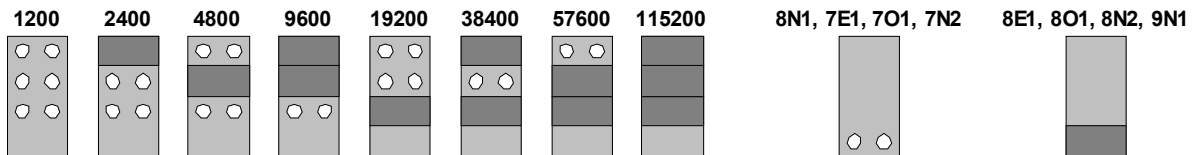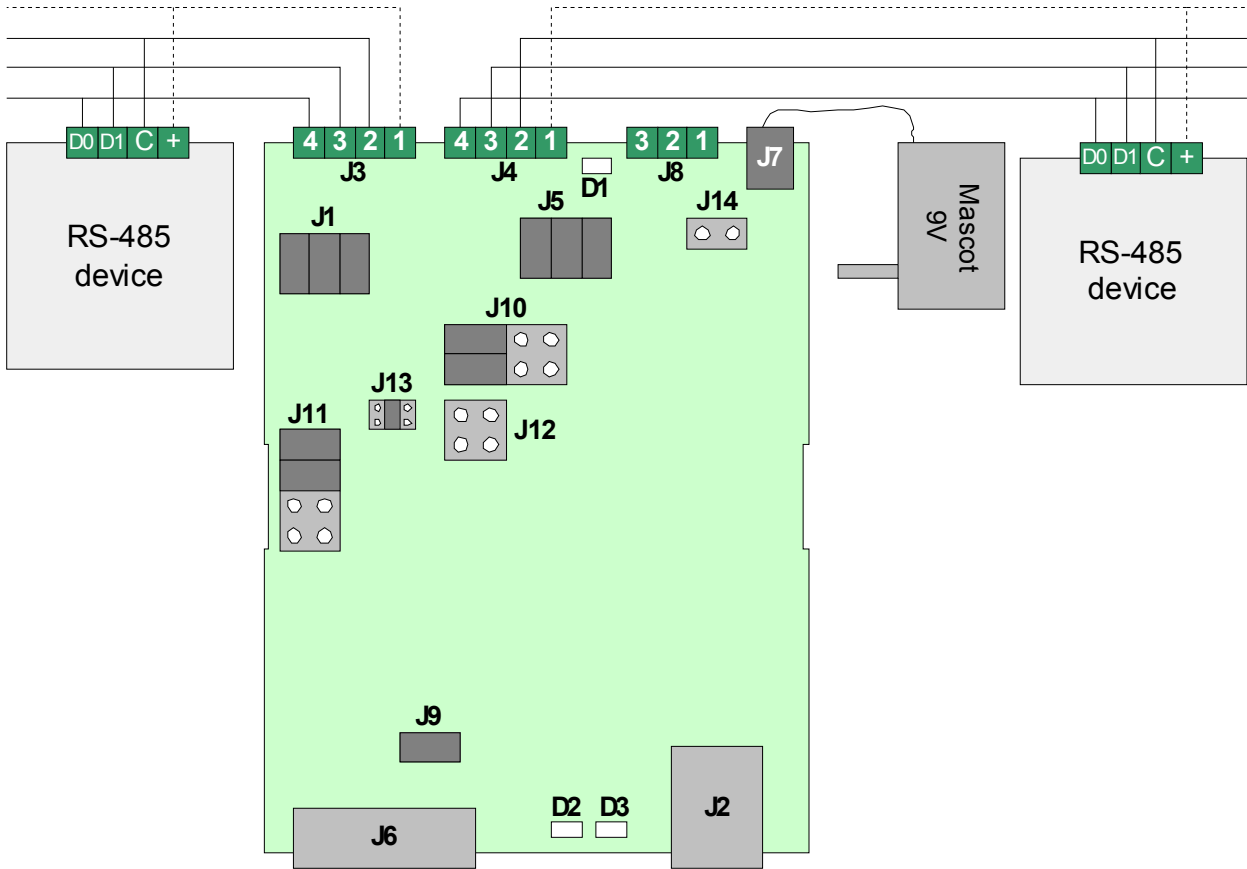
RS-232 — RS-422

Jumpers

- 232–422 mode is selected with jumpers J9, J10, and J12 according to the picture.
- J1 and J5 define 422 bus termination, see page 14.
- J14 controls power supply options, see page 10.
- J11 selects the baud rate and bit format, see picture below.

Connectors

- J3 is RS-422 Tx and J4 is Rx. See page 14.
- RS-232 is explained on page 15.
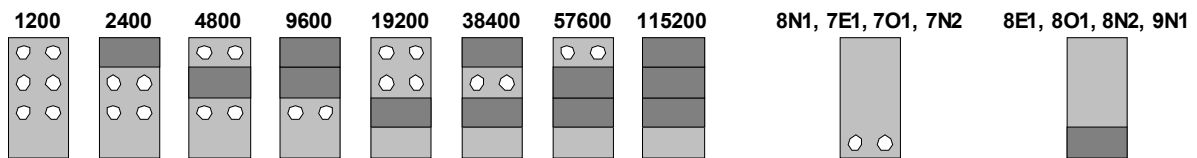- An external power supply must be connected in J7 or J8, see page 10.

RS-485 REPEATER

Jumpers

- 485 repeater mode is selected with jumpers J9, J10, and J12 according to the picture.
- J1 and J5 define the 485 bus termination, see page 12.
- J14 controls the power supply options, see page 10.
- J11 selects the baud rate and bit format:

Connectors

- J3 and J4 are the RS-485 buses. Data on either bus is repeated onto the other.
- This converter must be powered up from an external supply brought to connector J7 or J8. See page 10.

SUPPLY VOLTAGE

Supply voltage for RCS770

If USB is used, RCS770 does not need other power supply for itself. If USB is not used, an external power supply is needed.

The external supply is connected to connector J7 or J8. If you use J8, read the section "Jumper J14" below.

J7 is a 1.3 mm DC jack and it accepts voltage between 8 and 28 VDC. If 230 VAC socket is available, Nokeval recommends Mascot 8311-9V-3635 AC/DC adaptor, available separately.

Supply voltage for the bus devices

It is sometimes convenient to build the RS-485 bus with a four wire cable consisting of common, power supply, and two data lines. This is why RCS770 has four terminals on each bus connector: one of the terminals is reserved for supply voltage. RCS770 does not generate this supply voltage and it must be brought to connector J8 or J7. If you use J7, read the section "Jumper J14" below.

RCS770 itself does not care which way the bus devices are powered. This power supply routing is provided only to make the cabling easier.

The voltage can be anything as long as it does not exceed 30 VDC because there is a 33 V varistor protecting from voltage surges.

Jumper J14

If jumper J14 is open, J7 is used to provide the supply voltage for RCS770 itself and J8 is used to provide the supply voltage for the RS-485 bus devices.

If jumper J14 is closed, these two circuits are interconnected. You can bring the external power supply at either J7 or J8 and in both cases the same power supply will be used for both RCS770 and the bus devices.
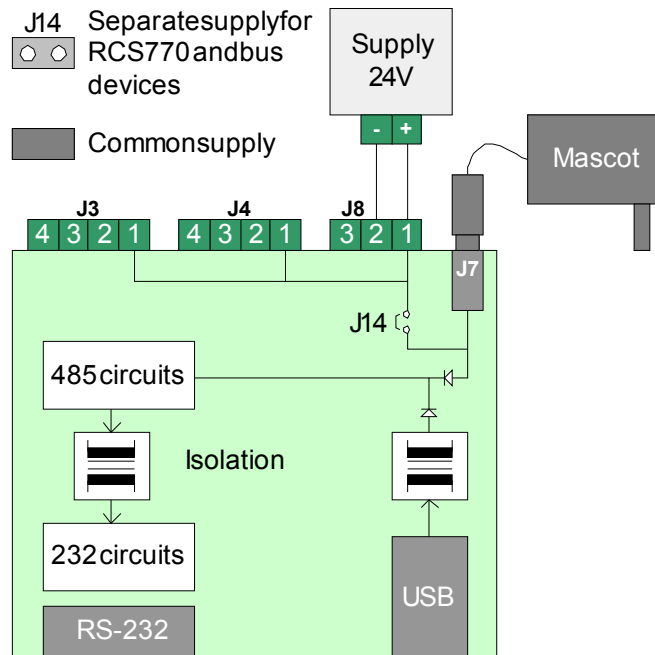
USB

Installing the drivers

There are two ways to install the USB drivers.

Found New Hardware wizard

If you just plug in the device, the Found New Hardware wizard will be triggered.

The drivers can be obtained from:
• Nokeval Software CD or
• Windows Update (XP only)
• Downloaded from the USB chip manufacturer http://www.ftdichip.com/, VCP drivers for FT232R.

The wizard is launched twice: the first drivers are the USB drivers, and the second driver creates a virtual serial port in Windows.

Pre-installing the driver

Another way to install the drivers is to run a setup file in the Nokeval Software CD before plugging in the device. The device can then be plugged in and all is done.

When the drivers are successfully installed, the power indicator on RCS770 should light up.

Virtual serial port

The USB driver creates a virtual COM port in the next unused port number. To find out which port we got, go to the Device Manager (Control Panel, System, Hardware, Device Manager). In the device tree, expand branch Ports, and you should see e.g. USB Serial Port (COM3).
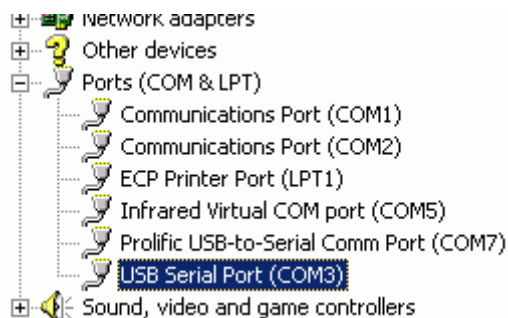
If you double click the port, you can change its properties. The most useful thing is the ability to change the port number (Port Settings, Advanced).

USB hubs

If RCS770 is connected to a USB hub, the hub should have a power supply of its own as always if any of the devices draw more than 100 mA current.

RS-485 BUSES

The RS-485 bus has two data lines delivering the data. The polarity of the voltage between the lines defines whether a bit indicating 'zero' or 'one' is being transferred. Several devices can be attached to the bus. Only one of them can transmit at a time, while the others listen. Thus the communication is half-duplex.

Connections

RCS770 has four terminals for each RS-485 bus: D1, D0, Common, and +. The first three of these form the RS-485 bus and the fourth, optional line allows easy power supply wiring for the bus devices.

D1, D0, and Common are wired one-to-one to the other devices on the bus. D1 and D0 are the data lines. Common is needed to remove potential differences between the devices, and it may serve as the negative power supply wire too.

Some older devices do not have a Common terminal available. In that case, connect the lines D1 and D0 only. If RCS770 is not wanted to terminate, set the jumpers J1 and J5 to "2-wire" position instead of "Not term".

The two buses (J3 and J4) are equal. The data coming from USB or RS-232 is transmitted on both of the buses, and data coming from either of the buses is delivered to USB or RS-232.

There has been quite rich use of names for the data lines. Even EIA/TIA recommended "A" and "B" have been used with two meanings. Nokeval has decided to use the names defined by Modbus standard, D1 and D0. The table below lists common names for the lines:

D1	D0
+	-
B	A
A	B
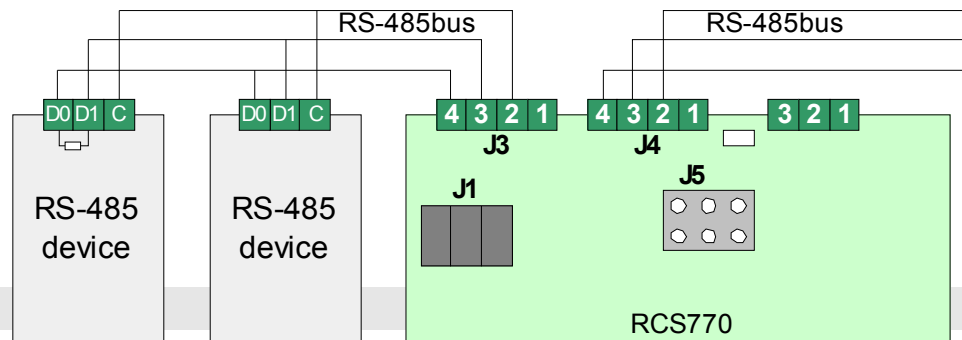
Cable

The D1 and D0 should be of a twisted pair, minimum diameter 0.5 mm (24 AWG). In a noisy environment a shielded cable should be used, the shield grounded at one end only.

A daisy-chain wiring topology is recommended. If braches or stubs are made, they should be only a couple of meters long.

Terminating and fail-safes

If the bus is longer than some dozens of meters or if high baud rates are used, the bus must be terminated in order to avoid reflecting the signal from the bus ends. The reflections will cause bit errors.

Fail-safe resistors are needed to ensure the correct state on the bus when nobody is transmitting. They create va voltage of at least 0.2 V between lines D1 and D0. Each bus should have only one device fail-safing.

The termination and fail-safes of RCS770 are controlled with jumpers J1 (for bus at J3) and J5 (for bus at J4). Factory setting is both fail-safes and termination on.

The termination provided by RCS770 is of AC type: the terminating resistor (110 ohms) has a capacitor in series (1 nF). The fail-safes are 500 ohms from D1 line to +5V and 500 ohms from D0 line to ground.

Direction control

USB

When a computer sends data via USB, the RS-485 transmitters are enabled automatically. When the last bit has been transmitted, the transmitters are immediately disabled in order to be able to receive data from the RS-485 bus.

RS-232

When some data is sent to RCS770 via RS-232, RCS770 buffers it one byte duration. After that, it activates the RS-485 transmitters, waits another 1/2 bytes and then starts transmitting the data on the bus. When the last bit has been transmitted, the RS-485 transmitter is disabled to allow receiving data.

Because the direction is controlled automatically, the RS-232 handshake lines are not used.

RS-485 repeater

RCS770 listens to both buses. When data is received from either bus, the transmitter of the other bus is enabled and the data is repeated there 1.5 bytes delayed. When there is no incoming data for 1/2 bytes, the transmitter is disabled and both buses are listened to again.

RS-422 BUS

RS-422 bus consists of two separate wire pairs, one for each direction. This allows full duplex communications.

Connections

The wire pair carrying data from RCS770 to the other device is connected in connector J3, and the other pair is connected in connector J4. In addition, a Common or potential equalisation wire should be connected from connector J4 terminal 2 to the other device.

There are various names for the RS-422 lines, but the table below lists some:

| Terminal	J3.3	J3.4	J4.3	J4.4
Modbus	TXD1	TXD0	RXD1	RXD0
Old	Tx+	Tx-	Rx+	Rx-
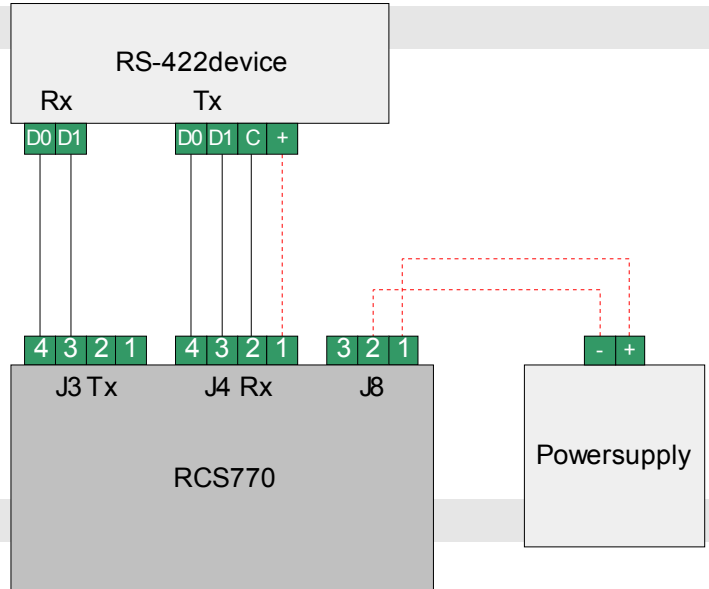
Cable

The cable should consist of twisted pairs so that TXD1 and TXD0 form one pair and RXD1 and RXD0 another. The minimum recommended diameter for the cable is 0.5 mm (24 AWG). In a noisy environment a shielded cable should be used, the shield grounded at one end only.

Terminating and fail-safes

In RS-422 bus, both wire pairs have always one transmitter enabled. There is no benefit in terminating or fail-safing the transmitting end of the wire pair. So it is recommended to enable the termination and fail-safes of the receiving end only: in RCS770, jumpers J1 should be set "Not term" and J5 "Term + FS".
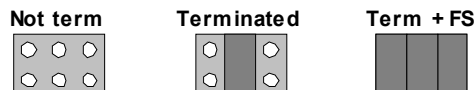
RS-232 PORT

Pins

The RS-232 port of RCS770 is of "DTE" or "data terminal equipment" type, similar to the port on PC's. So RS-232 devices can be connected to RCS770 with similar cable that would be used between the device and a PC.

If RCS770 is connected to a PC using an RS-232 bus, a cross-connected (also called as "null-modem") cable must be used. It is enough to connect pins 2-3, 3-2, and 5-5.

Pin	Name	Purpose	Direction
1	DCD	Carrier detected	In
2	RxD	Data receive	In
3	TxD	Data transmit	Out
4	DTR	RCS770 is ready	Out
5	Gnd	Ground	
6	DSR	Other device is ready	In
7	RTS	RCS770 requests to send	Out
8	CTS	Other device allows to send	In
9	RI	Telephone ringing	In
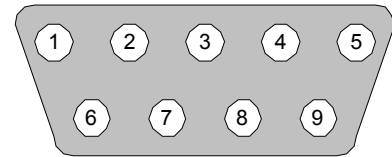
Handshake lines

RCS770 is intended to be primarily a USB-RS-485 or RS-232-RS-485 converter, not USB-RS-232, although possible. Consequently the RS-232 handshake lines are not controllable, but they are interconnected as follows:

DTR is connected to DCD and DSR. RTS is connected to CTS.

TROUBLESHOOTING

The indicator lights are useful in troubleshooting. Unfortunately the Tx and Rx indicators work only when USB is used.

Step 1: Drivers and supply voltage

Is indicator D1 lit?
- Yes: go to step 2.
- No and USB is used: reinstall the drivers.
- No and USB is not used: check that there is an external power supply connected in J7 or J8. If the power supply is connected in J8, make sure that jumper J14 is closed.

Step 2: Transmission

Start the application on PC. Examine, if the Tx indicator is blinking. If not, the application is using a wrong COM port probably. This test is not applicable if USB is not used.

Step 3: Reception

If Tx is blinking but Rx is not, your RS-485 device is not responding. Check that it is powered up, the connections are correct, and the baud rate and serial address are correct.

Step 4: Bus voltage RS-485

Use a multimeter to measure the voltage between data lines D1 and D0. It should be 0.2 to 5.0 volts, D1 being the positive. If the voltage is 0, the bus is short-circuited or there are no fail-safes.

Measure the voltage at each bus device and pay attention that the polarity is correct (D1 positive).

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