Application Guide for Installation and Cabling of the Communications Option for
CAL 3300 / 9300 / 9400 / 9500 Controllers

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CAL Controls

Introduction

The 3300 / 9300 / 9400 / 9500 series controllers can all be ordered or retrofitted with either an RS232 or RS485 serial communications interface board. If the controller has the communications interface fitted then skip to the section titled **Installation/Cabling**.

Feature	RS232	RS485
Type of transmission lines	Unbalanced	Differential
Maximum number of drivers	1	128
Maximum number of receivers	1	128
Maximum cable length	15m	1200m
Maximum data rate	19.2Kb/sec	19.2Kb/sec
Maximum CMV	+/- 25V	+12 to -7V

Table lists the features of both RS232 and RS485 standards.

Cable: To ensure data integrity over long transmission distances, it is recommended that good quality RS485 cable is used.

Recommended: RS485: Belden 9841, RS232: Belden 9501 available from most leading distributors, and stocked by CAL.

FITTING A COMMUNICATIONS INTERFACE BOARD

The RS232 and RS485 interface boards are interchangeable and are fitted in exactly the same way, please read the fitting and safety instructions before proceeding.

> ⚠️ **Caution:** Live circuits can hold charge for short periods after isolation from the voltage supply.
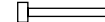>
> Electrostatic precautions should be observed when handling the controller outside the sleeve.

After isolating the controller from it's supply, the controller front bezel and circuit board assembly can be unplugged from the sleeve. Grasp the bezel firmly by the recesses on each side and pull. A screwdriver can be used as a lever if required.

To fit the RS232 or RS485 interface you will require the following parts, which are supplied with the interface.
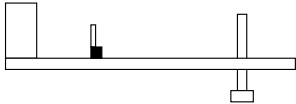
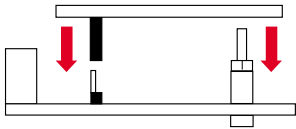|			
⬡	Nylon Full Nut Code – 082-042	▬	Nylon Screw Code – 082-028
⬡	Brass Half Nut Code – 082-041	⬚	Nylon Spacer Code – 082-012

Insert the Nylon Screw into the 3mm diameter hole at the bottom left hand corner of the 3300 / 9300 / 9400 / 9500 board.
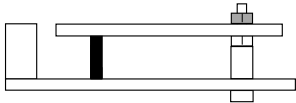
Place spacer over Nylon screw thread.

Screw the Nylon Full Nut onto the screw.
Do not overtighten as this will damage the screw thread.

Plug the 5-way female connector on the Comms Board into the 5-way male connector on the Controller board ensuring that connectors are all in alignment. At the same time ensure the hole in the Comms board fits over the screw thread.

Screw the Brass Half Nut onto the Comms board. Do not overtighten but ensure it's tight enough to stop the board from moving.
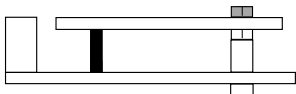
Cut the top of the screw thread so that it is level with the top of the Brass Half Nut.

Now you are ready to refit the Controller into its case. To do this carefully slide the PCB into the case aligning it with the connector arms at the rear, and then press the bezel assembly firmly into the sleeve until the latch clicks in order to compress the gasket and seal to NEMA4/IP66.

Diagram 1

Installation / Cabling

RS232 CONNECTIONS

RS232 is the standard most widely used for interfacing peripherals to PC's and is designed for serial communications with single instrument up to distances of 15 metres, in a low electrical noise environment.

Connection is via a screened two core cable where the voltage signal on each line is referenced to the screen which is grounded. Most PC's have one or two RS232 compatible ports fitted as standard.
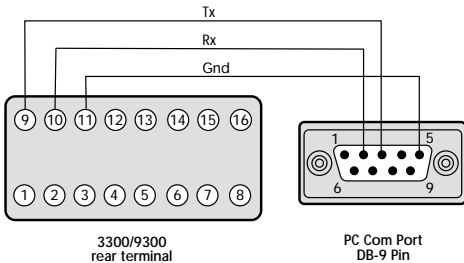

Diagram 2

RS485 CONNECTIONS

RS485 is a half duplex serial communications link and is the standard most commonly used for industrial applications due to it's high noise immunity and multi-drop capability. It enables a PC to communicate with up to 128 instruments over distances up to 1200 metres, and requires the addition of an RS485 interface card, or a separate RS232 / 485 converter.
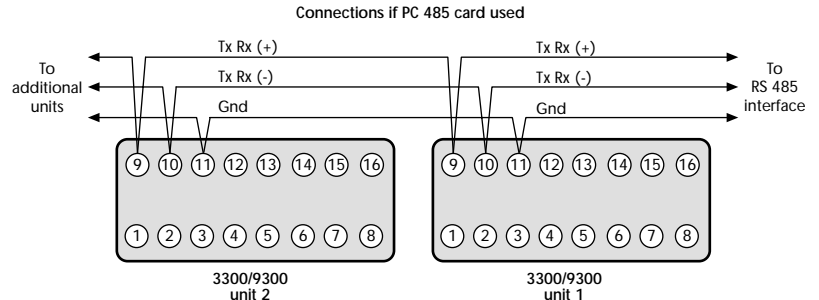

Diagram 3

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Each RS485 interface has specific connection and termination biasing requirements which will be detailed in their installation instructions. The general principals are as follows.

Terminations Because each wire is a transmission line, it must be properly terminated to prevent reflections. Where multiple instruments are daisy-chained together, a 120 ohm terminating resistor should be fitted at the connection to the PC and to the last instrument in the chain.

Diagram 4 Termination resistors

Bias Resistors When transmission lines are not transmitting, they remain in an indeterminate state which can allow receivers to receive invalid data bits due to electrical noise on the cable. To prevent this, the lines should be forced into a known state by fitting two 620 ohm bias resistors to one point (node).

If an RS485 interface card is being fitted to the PC, separate bias resistors may not be needed because they may already be fitted to the card. Check the manufacturers specification.

Diagram 5 Bias resistors

As mentioned earlier RS485 cards and converters differ greatly in their requirements and therefore the installation instructions supplied with the interface should be read carefully.
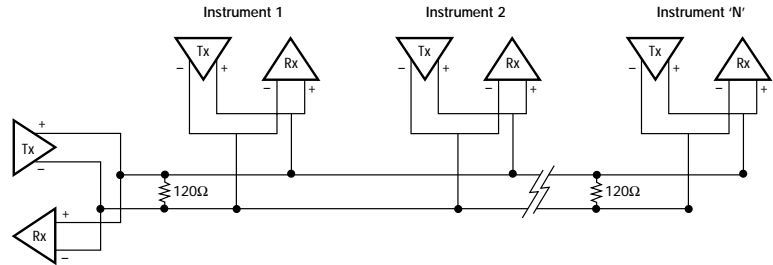
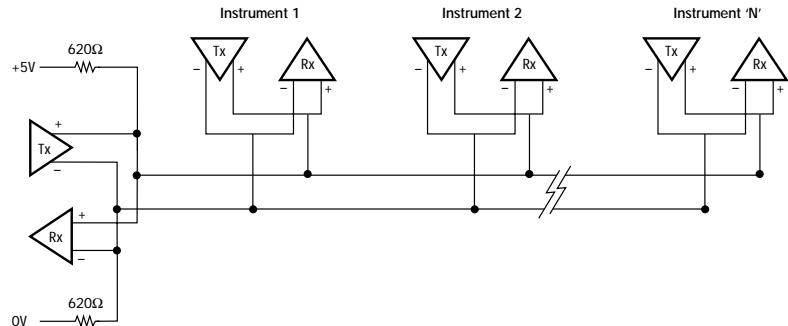## KK SYSTEMS K485ADE

If you have purchased the KK Systems RS232/485 converter from CAL Controls then the specific requirements for this converter are detailed here. Please note that the KK Systems K485ADE are only designed to work at 9600 baud rate, with 8 data bits, no parity and 1 stop bit.
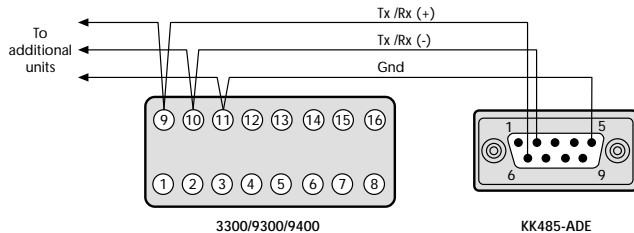

Diagram 6

Termination Resistors It is not generally possible to derive sufficient power from a PC232 port to drive a 120Ω resistor with RS485 voltage levels. A capacitor e.g. 1000pF should be connected in series with any such terminator, to eliminate the DC loading which a resistor alone would produce.
Note: The controlled slew rate driver used in this converter makes termination at either end of the bus unnecessary for cables shorter than approximately 300m, this assumes the use of Belden 9841 cable.

Bias Resistors There are 2 100KΩ bias resistors fitted internally to the converter, so generally this should be sufficient.

We recommend that before you proceed further you check that there is sufficient power derived from the serial port to drive all the connected controllers. The power you can derive from PC serial ports varies greatly from PC to PC, and the amount of power needed to run the RS485 bus varies according to the length of the cable, the number of instruments connected, and the biasing requirements.
To check whether there is sufficient power measure the voltage present on pin 9 of the 'D' connector relative to ground. This must be at least 5.5V at all times. It is important to measure the voltage on pin 9 with all the controllers connected. If the power derived from the serial port is insufficient, an external power supply can be connected to pin 9 of the connector.

The details above are general requirements, if you are installing more than 20–30 controllers, or more than 300m of cable, then additional biasing and power will be required.

To fit additional biasing you need to connect two 620 Ohm resistors externally as shown in diagram 5. This then requires an external power supply to be fitted, this provides the extra power for the biasing resistors, and also the power to drive all 128 controllers over 1200 meters.

EXTERNAL POWER SUPPLY

The recommended external power supply requirements are +5.5V to +14V and min 100mA.

Instrument Comms Settings

Immediately after power-up, both instrument, and PC comms settings need to be made compatible before communication between them is possible. Instrument defaults are shown below together with available options.

⚠️ **Addr** (Address) This is a unique identification number that must be allocated to each instrument connected to the network.
Default = 0. Options; *1 to 247*

bAud (Baud rate) The setting determines the serial communication data transmission rate in bits/sec, and must match the PC settings.
Default = 9600.
Options;
1200; 2400; 4800; 9600 and 19200
NOTE: If a comms board has been retro fitted the default baud rate is 1200.

dAtA (Data) Sets the transmission format, and must match the PC settings

Data Format Table

Settings	Start bits	Data bits	Parity	Stop bits
Default	1	8	n (none)	1
Option 1	1	8	e (even)	1
Option 2	1	8	o (odd)	1

dbuG (Debug) Commissioning and troubleshooting aid. Display shows when the instrument is transmitting or receiving data by rapidly flashing the three horizontal segments of the first and last digit of the display.
First digit = Tx; last digit = Rx
Default = Off. Options; *off; on*

Only use dbuG during commissioning or trouble-shooting because it shares display segments and therefore corrupts the normal display.

Configuring Instrument Comms Settings

This should also be done immediately after power-up, and is only possible from the instrument front panel.

On power-up the controller will display the self test sequence followed by Alternating `, nPt` and *nonE*

Note: During the following procedure the display will revert to alternating `, nPt` and *nonE* after 60 seconds of keying inactivity, but will retain any settings already completed. Should this occur, or in the event of becoming 'lost' in the program, please start again from the alternating `, nPt` and *nonE* display.

To select Level C (communications settings)
Press ▼ once display alternates `LEUL` and *5*
Press and hold ✶ and press ▼ five times to reach **level C**
display alternates `LEUL` and *C*

Note: Level C is only visible when the comms interface board is fitted to the unit

⚠ To set instrument comms address
Press ▲ once display alternates `Addr` and *0*
Press and hold ✶ and press ▲ to index to chosen address number *(1 to 247)*

Note: In the absence of any conflicting information the following comms settings should be left as the default values (see details on page 7).

To read or adjust comms settings
Baud rate
Press ▲ once display alternates `bAud` and *9600* **(Default setting)**
Press and hold ✶ and use ▲ or ▼ keys to select preferred value.

Data format
Press ▲ once display alternates `dAtA` and *18n1* **(Default setting)**
Press and hold ✶ and use ▲ or ▼ keys to select preferred setting. (see table page 7).

Debug setting
Press ▲ once display alternates `dbuG` and *oFF* **(Default setting)**
Press and hold ✶ and use ▲ key to select *on*

To enter settings into memory
Press and hold ▲ and ▼ for 3 seconds display alternates `, nPt` and *nonE*

To check settings; repeat the above procedure

The unit is now ready to be configured from the PC.

Note: Where more than one instrument is connected to the system, it is useful at this point to list them by location, title and comms address. The list can then be used as a reference to ensure that the instruments are given the same identity when configuring the comms link from the PC.

Application Software

The controllers with the communications interface fitted use the Modbus RTU protocol. If you wish to integrate the controllers into a third party software application, or code your own custom software application, there is a document that explains how to communicate with the controllers. The document is entitled Cal 3300/9300/9400/9500 Modbus RTU communications guide, and is available from CAL Controls Ltd.

CALCOMMS™ APPLICATION SOFTWARE
The easiest way to communicate with the controllers is using the dedicated CALCOMMS™ package for remote configuration and data acquisition. This package requires no programming or configuration and is ready to run, if you are familiar with Windows95/98 you can be up and running in minutes.

CALCOMMS™ PC REQUIREMENTS
To gain the full benefit of CALCOMMS™ software, it is recommended that the PC is fitted with a Pentium processor and is running Windows95/98 or WindowsNT and has a graphics card capable of displaying a minimum of 256 colours. A minimum of 16Mb of RAM for Windows95/98 and 32Mb of RAM for WindowsNT are recommended, together with enough free hard disk space to meet your logging requirements.

CALCOMMS™ PERFORMANCE CONSIDERATIONS
When an application has more than 32 instruments on the bus, we recommend you look at using a higher specification PC. If you have between 32 and 128 instruments on the bus a recommended minimum PC specification would be a Pentium 200MHz processor with 64Mb of RAM. To keep CPU and RAM usage to a minimum it is generally good practice not to log data more frequently than necessary, and also keep the time base of charts as small as reasonably possible. If you need to review the full chart history you should select 'View Plot' mode and then increase the time base of the chart, remember to return to 'Auto Plot' mode when finished. If possible you should also increase the 'Refresh Frequency' option in the 'Select Units To Chart' screen. This option allows you to keep logging data in the background, but only redraw the chart when 'X' number of samples have been acquired from each controller. For instance if the 'Sample Frequency' is set to 1 second and the 'Refresh Frequency' is set to 20, the chart will only be redrawn and updated every 20 seconds, but logging still continues in the background at the rate of once per second. For more detailed information on tuning the performance of CALCOMMS™ to your application requirements, contact CAL Controls Ltd.

Additional information
SETTING SECURITY LEVELS IN CALCOMMS™
It should be noted that functions that have been locked appear to be still locked even when you are logged in at the correct security level. This means that the operator or supervisor have permission to unlock and adjust functions they have locked, but have to unlock that function first, then they can adjust the function. To retain your security settings remember to re-lock any functions you have unlocked for adjustment.

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