User Guides 2021
L&R Ing. DIN RS485 Board/Module

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1. INTRODUCTION

The DIN RS485 board / module from L&R Ing. (Figure 1) contains a user-configurable circuit which allows it to be used in three different data communication systems. It can serve as a bridge **a)** between an RS-485 network and an RS232 port, **b)** between a conventional serial TTL (RxD/TxD 5V) port and RS485 (with Auto-Enable or external Enable TTL signal), or **c)** between the same 5V TTL port and an RS232 port, with only Rx and Tx signals. These configurations are set by jumpers JP1 on the board. A low-dropout LM2937-5 regulator supplies power for the circuit from an external source between 7 and 25 Vdc. Consumption is typically 0.05 A @ 12.8 V. A complete schematic diagram can be seen in Figure 2.

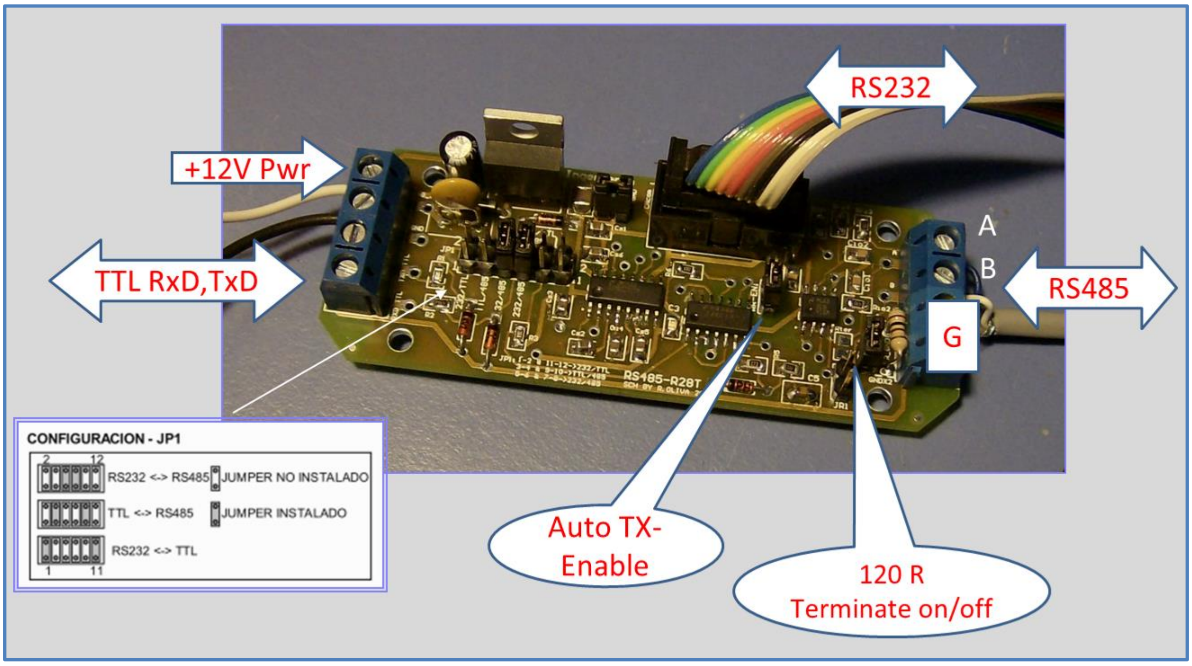

Figure 1 – Diagram of DIN-RS485 board

2. BACKGROUND

L&R Ing. DIN RS485 boards cover electronic data communications between elements over serial lines, which will generally fall into two broad categories: single-ended and differential [Ref0a, b].

2.a RS232: (single-ended) or EIA232 was introduced half a century ago and due to its simplicity has remained widely used throughout the industry. The specification allows for data transmission from one transmitter to one receiver at relatively slow data rates (up to 20K bits/second) and short distances (up to 16m @ the maximum data rate). If two-way (full-duplex) communications are required, independent channels must be established. The RS232 signals are represented by voltage levels with respect to a system common (power / logic ground). The "idle" state (MARK) has the signal level negative with respect to common, and the "active" state (SPACE) has the signal level positive with respect to common. RS232 has numerous handshaking lines (primarily used with modems), and also specifies a communications protocol, but for simple applications only the receive (RxD) and transmit (TxD) lines are used, as is in the L&R Ing. RS485 board.

2.b RS485: (differential) was designed for greater distances and higher Baud rates than RS232. RS485 meets the requirements for a truly multi-point communications network, and the standard specifies up to 32 drivers and 32 receivers on a single (2- wire) bus. With the introduction of "automatic" repeaters and high-impedance drivers / receivers this limitation can be extended to hundreds of nodes on a network. RS485 extends the common mode range for both drivers and receivers in the *tri-state* mode and with power off. Also, RS485 drivers are able to withstand *data collisions* (bus contention) problems and bus fault conditions.

To solve the *data collision* problem often present in multi-drop networks hardware units (converters, repeaters, micro-processor controls) can be constructed to remain in a receive mode until they are ready to transmit data. Single master systems (many other communications schemes are available) offer a straight forward and simple means of avoiding data collisions in a typical 2-wire, half-duplex, multi-drop system. The master initiates a communications request to a slave node by addressing that unit. The hardware detects the start-bit of the transmission and automatically enables (on the fly) the RS485 transmitter. Once a character is sent the hardware reverts back into a receive mode in a few microseconds.

Any number of characters can be sent, and the transmitter will automatically re-trigger with each new character (or in many cases a *"bit-oriented"* timing scheme is used in conjunction with network biasing for fully automatic operation, including any Baud rate and/or any communications specification, for example 9600,N,8,1). Once a slave unit is addressed it is able to respond immediately because of the fast transmitter turn-off time of the automatic device. This avoids the need to introduce long delays in a network to avoid data collisions.

2.c Specifications: (Table source: adapted from [Ref0b] R.E.Smith - https://www.rs485.com/)

SPECIFICATIONS		RS232	RS485
Mode of Operation		SINGLE -ENDED	DIFFERENTIAL
Total Number of Drivers and Receivers on One Line (One driver active at a time for RS485 networks)		1 DRIVER 1 RECVR	32 DRIVER 32 RECVR
Maximum Cable Length		16 m	1300 m
Maximum Data Rate (13 m. – 1300 m. for RS485)		20 kb/s	10 Mb/s- 100 kb/s
Maximum Driver Output Voltage		+/-25 V	-7 V to +12 V
Driver Output Signal Level (Loaded Min.)	Loaded	+/-5 V to +/-15 V	+/-1.5 V
Driver Output Signal Level (Unloaded Max)	Unloaded	+/-25 V	+/-6 V
Driver Load Impedance (Ohms)		3k to 7k	54
Max. Driver Current in High Z State	Power On	N/A	+/-100 uA
Max. Driver Current in High Z State	Power Off	+/-6 mA @ +/-2 V	+/-100 uA
Slew Rate (Max.)		30 V/uS	N/A
Receiver Input Voltage Range		+/-15 V	-7 V to +12 V
Receiver Input Sensitivity		+/-3 V	+/-200 mV
Receiver Input Resistance (Ohms), (1 Standard Load for RS485)		3k to 7k	>=12 k

3. Diagram of DIN RS485 Board

L&R Ing. DIN RS485 boards (Figure 2) use a DS3695 RS485 converter IC, a DS14C232 RS232 IC, an LDO regulator and standard 74AC14 Schmitt-triggered input inverters to implement the auto-enable function, which works for most common baud rates. The 6 - JP1 position jumpers should be inserted in pairs as shown, to select the required functionality.

The RS232_EN jumper can disable the RS232 section to reduce power consumption if required. The WR-EN1 (Auto TX-Enable) jumper when inserted, enables the automatic EN signal to the DS3695 IC (EN High on pin 3, Low on pin 2). This signal enables the driver during every Start bit and logic-0 bit, and disables transmission after the Stop Bit, logic-1 or when transmission is idle, which occurs with the selected values about 20 us after data transmission ceases. Ideally this delay should be half of one bit width, but a slightly longer delay usually is no problem except at very high baud rates. Opening the WR-EN1 jumper, a CPU GPIO pin (5V logic) controlled by software can be easily implemented if required.

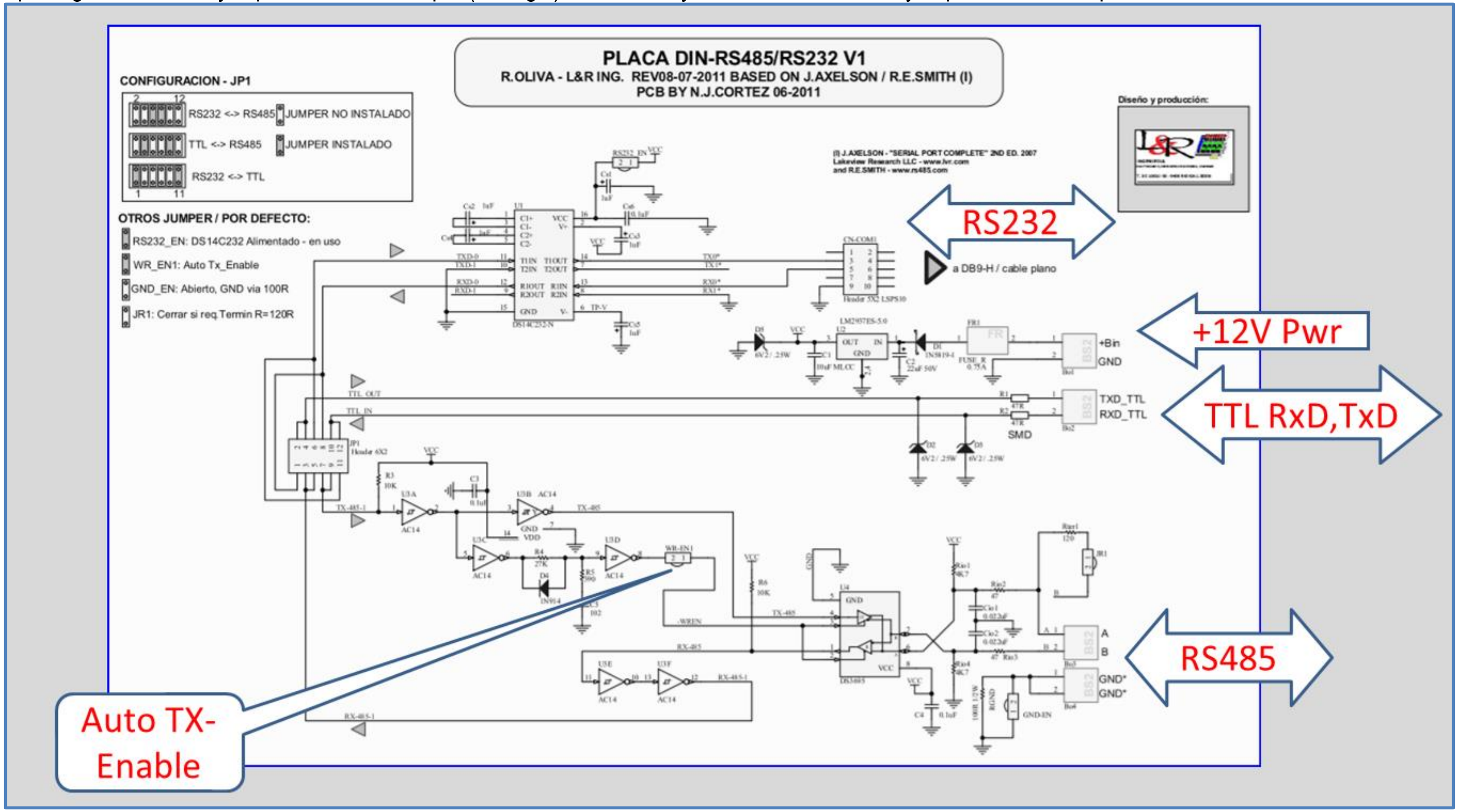

Figure 2 – Schematic and Functions of the DIN-RS485 board

4. APPLICATIONS

4.a INTI-Test Site: The DIN-RS485 boards, fully designed and built in Argentina with US-sourced components since 2012, have been extensively tested in-field and in laboratory / university applications. In Figure 3 the diagram of one of the possible configurations, converting TTL-level data @38400 baud to RS-485 over shielded FTP cable. In Figure 4 the end-use photograph of the units at INTI-Neuquén small wind turbine test site in Cutral Có, in one case 40 m length and the other 70 m length tower-based placement to main CPU input. Both units are in current operation.

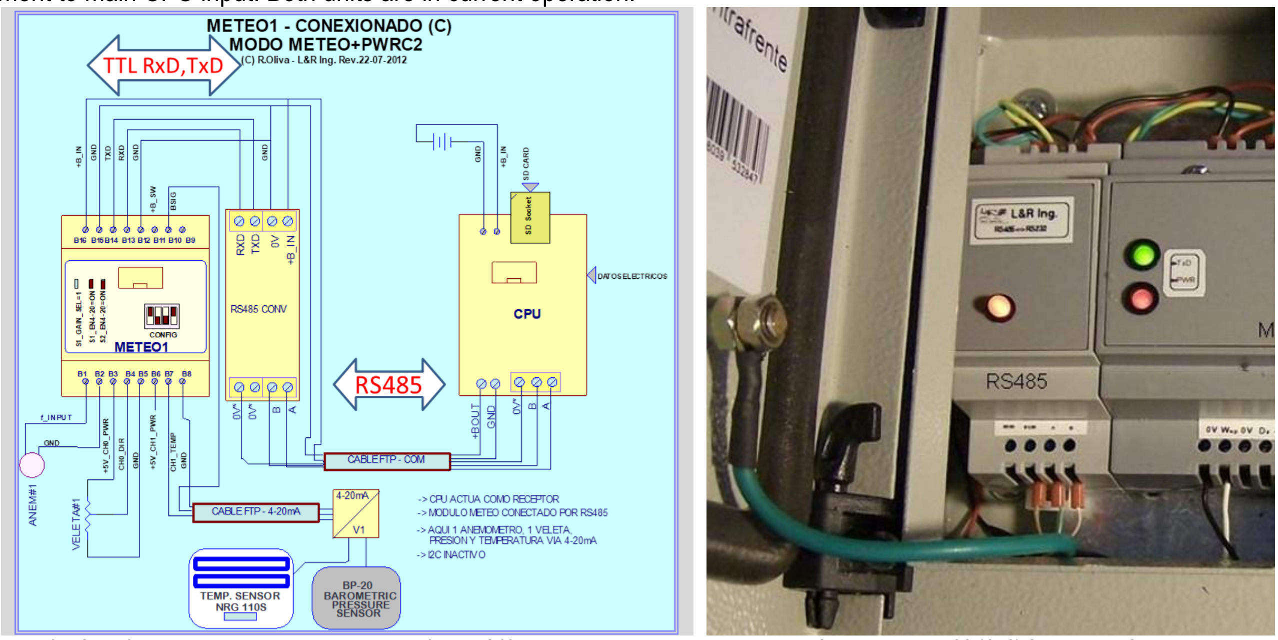

Figure 3 – One of the possible applications – Diagram of DIN-RS485 board serving as link between METEO units and PWRC2 (CL2) SWT-Power Curve Data Loggers

Figure 4 – Deployment of DIN-RS485 board in DIN-rail cabinet with METEO units in Cutral-Có (Neuquén) Small Wind Turbine Test Site

4.b Prototyping and testing: The DIN-RS485 boards are adequate for prototype testing, especially with projects requiring adaption of signals from RS232 (traditional serial ports), TTL level UARTs as in many CPUs and RS485 lines, very common in industrial and communication applications. Figure 5 shows a prototype application in RS232 to TTL mode jumper configuration, in this case an Arduino UART port to a PC, mounted on a wooden test platform. The configuration of the RS232 cable (DTE or DCE) can be selected according to the device accessed, using typically DB9-M or female in direct or crossover connections, as shown in Figure 6. L&R Ing. can provide guidance on self-construction using crimp-IDC connectors and flat cables, or provide fully tested assembled cables.

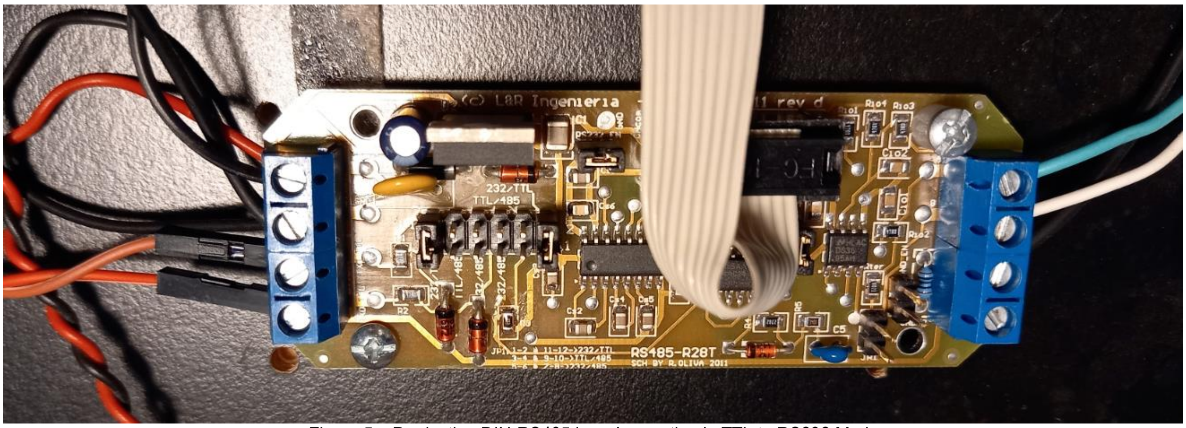

Figure 5 – Production DIN-RS485 board operating in TTL to RS232 Mode

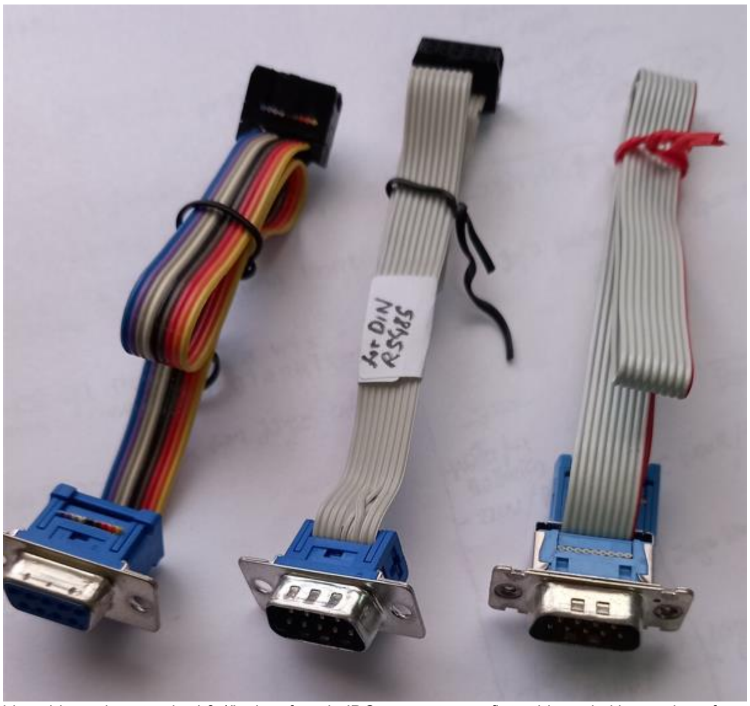

Figure 6 – RS232 side cables using standard 0.1" crimp female IDC connectors to flat cable and either male or female DB-9 connectors

4.c Connection to different CPU boards: The DIN-RS485 boards use the same circuitry as the RS485 interface ports on the CL2 (ATMega1284P) [Ref1] and CL3 (STM32F411 Cortex M3) [Ref2] CPU boards, so connection to these units is direct, for example when paired with METEO boards as shown in Figure 3 for the CL2. In Figure 7a and b the connection of a CL3 board (RS485 side) with METEO (TTL side) using a hand-assembled DIN-RS485 board is shown.

Figure 7a – Connection of CL3 and METEO board using DIN-RS485 board operating in TTL to RS485 Mode

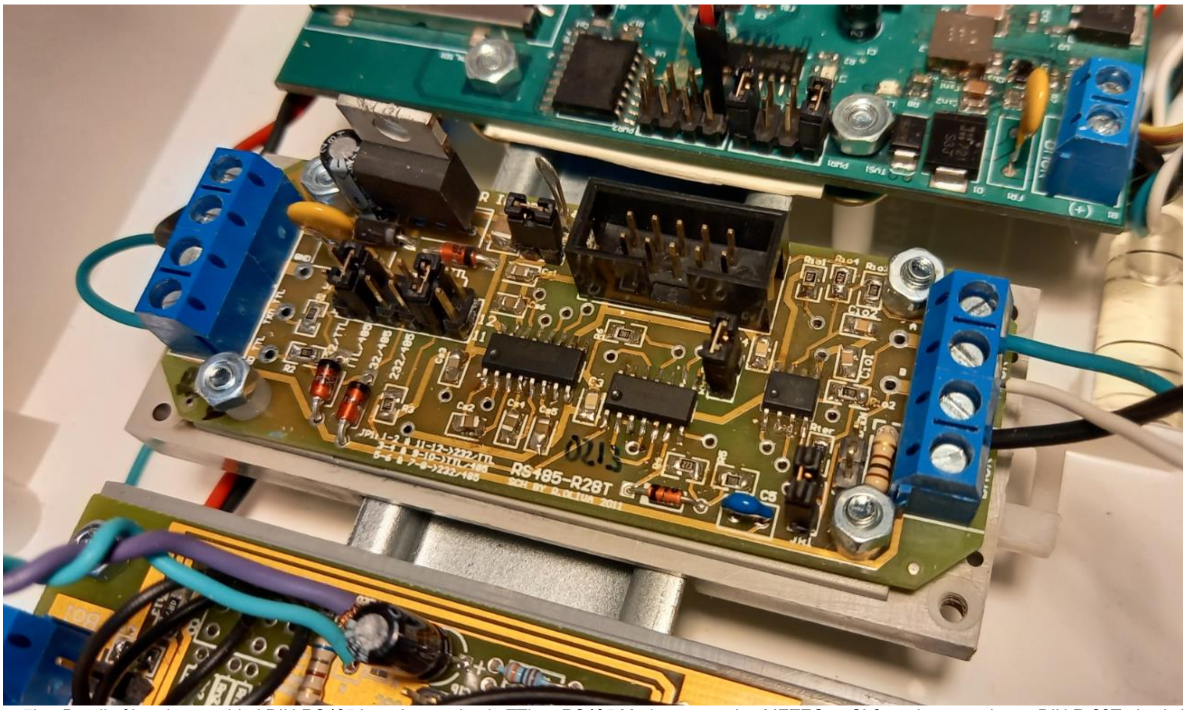

Figure 7b – Detail of hand-assembled DIN-RS485 board operating in TTL to RS485 Mode, connecting METEO to CL3, and mounted on a DIN R-28T plastic base

4.d Arduino Mega256 board to CR1000 Datalogger, and bus health test: A pair of DIN-RS485 boards are used to establish a Modbus link @19200 baud, at a UNPA university project currently under test. In this case, the Campbell Scientific CR1000 datalogger implements a main-loop Modbus Master, and connects its own RS232 port via DIN-RS485-1 board (in RS485-to-RS232 mode) to a 40 meter RS485-UTP link cable (Figure 8, left). On the right of Figure 8 a bus-health test of the RS232 section is shown measuring the TX0* signal in main schematic referenced to GND, showing adequate performance. The UTP cable connects to a second DIN-RS485-2 board coupled with an Arduino Mega 256, which internally reads the values of a DHT-22 Temperature /

Humidity sensor and updates a Holding-Register table which is exposed to the CR1000 logger using the Arduino-Modbus library configured as slave (Figure 9).

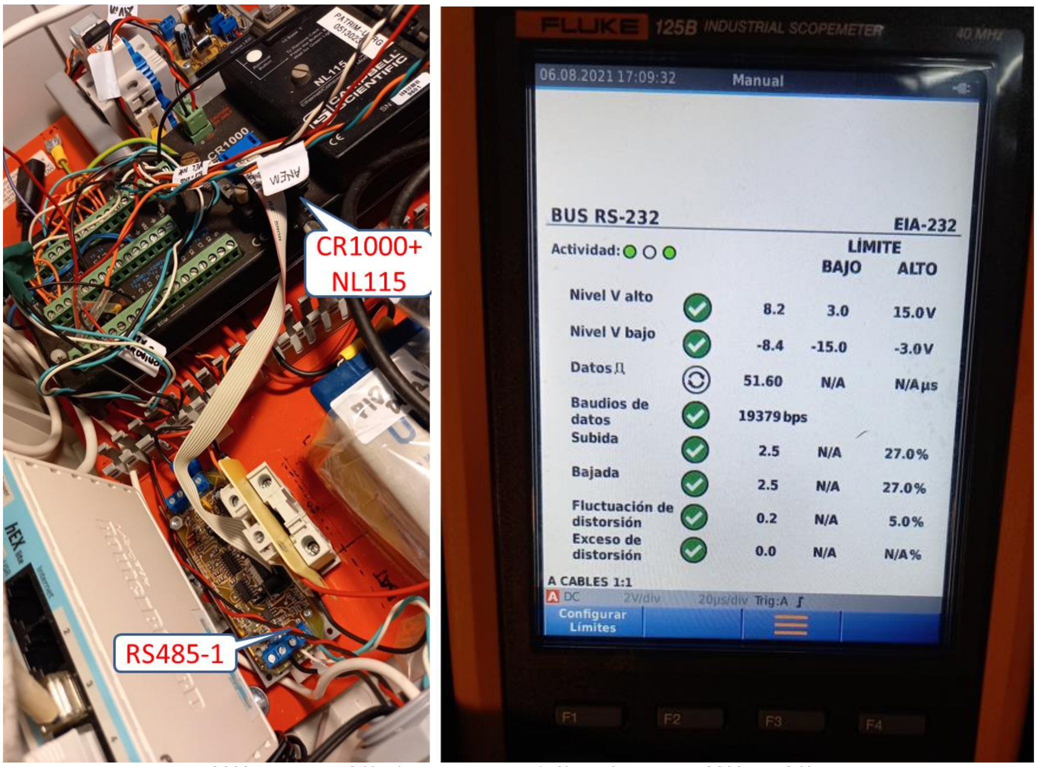

Figure 8 – CR1000 datalogger connected via its RS232 port to an RS485-1 converter board (left), configured as RS232-to-RS485 and linked the Arduino auxiliary system. The bus health test (right) was taken with a single probe connected to the TX0* output referenced to GND, using UNPA's F125B Scopemeter

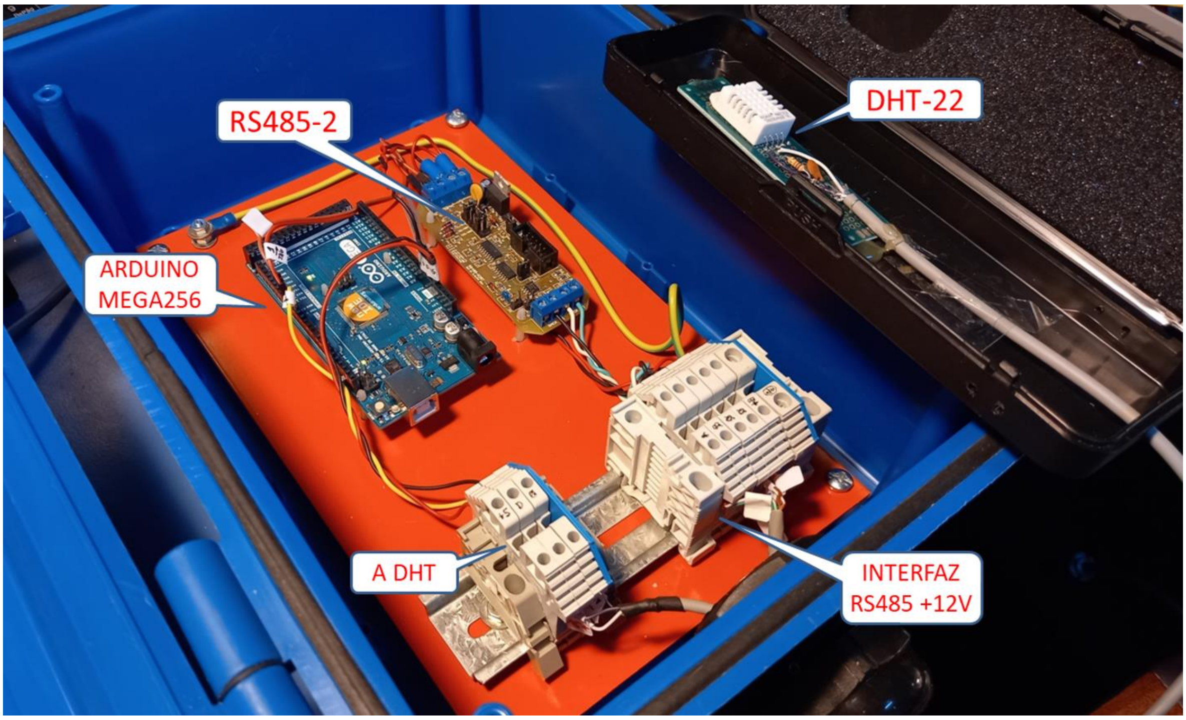

Figure 9 – Arduino Mega256 reading DHT22 sensor, connected to a second (RS485-2) converter board, configured as TTL-to-RS485 and linked to the central CR1000 logger.

In Figure 10 a Modbus-RS485 bus-health check is shown using the same instrument, coupled with both probes to the A,B outputs of the RS485-2 board, showing an adequate overall performance.

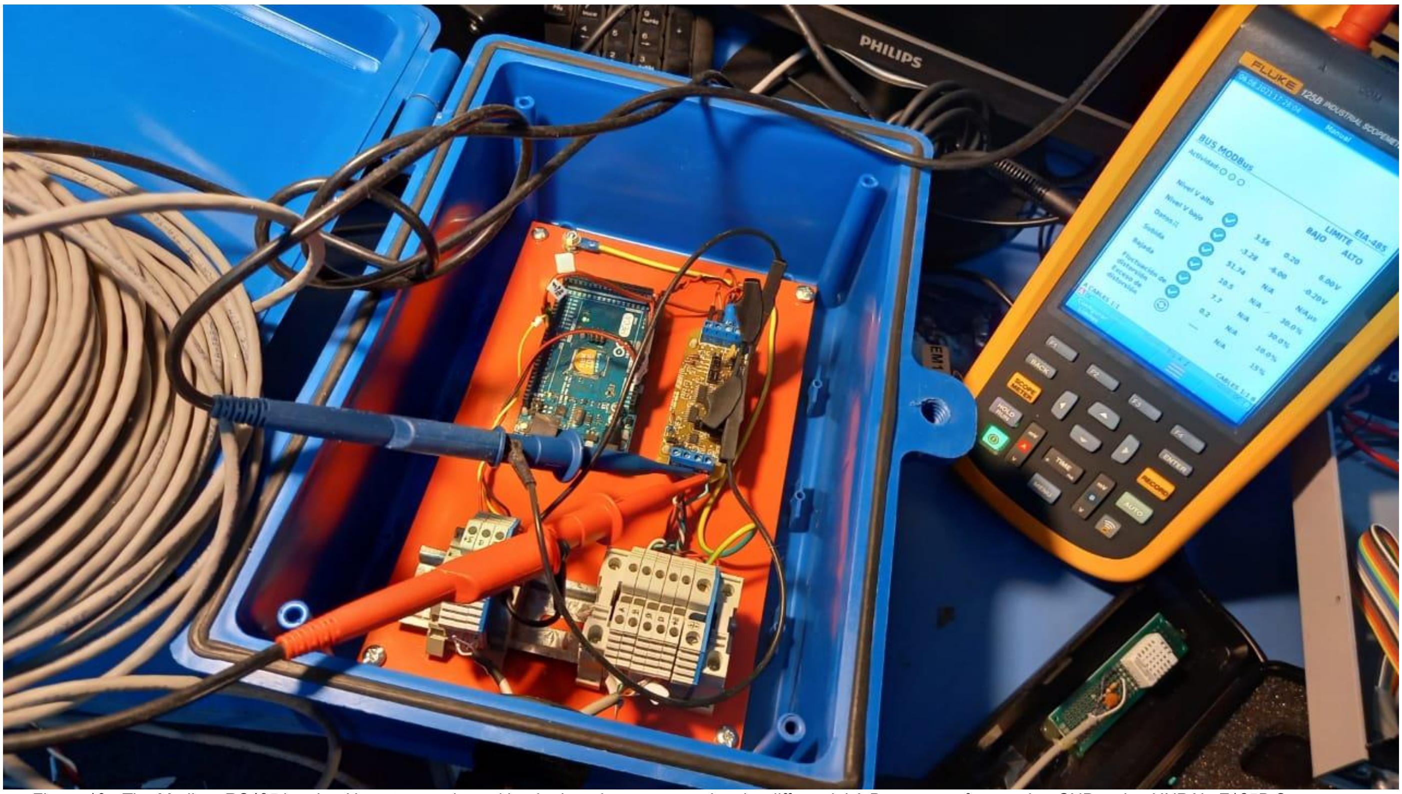

Figure 10 - The Modbus-RS485 bus health test was taken with a both probes connected to the differential A,B outputs referenced to GND, using UNPA's F125B Scopemeter

5. References

[Ref0a] Axelson, Jan - "Serial Port Complete" 2nd Ed. 2007 (ISBN 978-1931448-06-2) – Lakeview Research LLC - http://janaxelson.com/spc.htm
[Ref0b] R.E. Smith – RS485 Specialists https://www.rs485.com/
[Ref1] CL2b board and interfaces: https://www.lyr-ing.com/Embedded/LyRAVR_CyEn.htm
[Ref2] CL3 board: https://www.lyr-ing.com/Embedded/LyRCl3%2BM5E_En.htm
[Ref3] UNPA-AEA Site: https://www.energiasalternativas-unpa.net/

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NOTES: