



Checking the **Quality** of **Fieldbus Signals**

Physical integrity testing

Fieldbuses correspond to a series of electrical wires which convey information in digital form between 2 remote devices. A large number of bus protocols are used in the field, in a wide variety of sectors: industry, automotive, building automation, hospitals, etc.

Frequently-encountered bus protocols include KNX, DALI, CAN, LIN, FlexRay™, AS-i, Profibus®, RS 485, RS 232, ETHERNET, etc.

In computer networks, the physical layer is the first layer in the OSI (Open Systems Interconnection) model and it is responsible for effective transmission of the electrical or optical signals between devices. It is useful to measure this electrical physical level in order to optimize communication and draw up a diagnosis: change of cable, verification of chassis-earth, termination, etc.

We are going to look at the details of a test on an RS232 link between a multimeter and a PC with an oscilloscope offering the physical test in accordance with the applicable standards.

Industry

Automotive

Building Automation

Practical case:

Physical integrity test of an RS232 bus between a multimeter and the COM1 port of a PC

Equipment used

- SCOPIX BUS OX 7204: oscilloscope bus analyser
- HX0130 probe: voltage probe
- HX0190 DB9 board: RS 232 communication board for training purposes
- MTX 3283: 100,000-count on-site digital multimeter
- SX DMM: data retrieval software for the MTX 3283

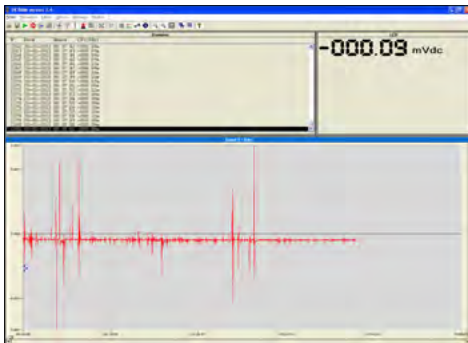


Did you know?

The MODBUS protocol is a dialogue protocol based on a hierarchical structure involving several devices.

Step 1

The MTX Mobile MTX 3283 multimeter is connected using an RS232 link, set to 9,600 bauds with the MODBUS protocol by using the SX-DMM multimeter data processing software.



Example of DC voltage acquisition

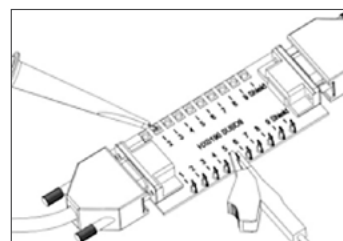
Step 3

The **HX0130** probe is connected to channel 1 of the SCOPIX at one end and, via the chassis-earth grip, between pins 2 or 3 and 5 on the **HX0190** connection board at the other end.



Step 2

You plug the **HX0190** DB9 connection board into the PC's COM port (the SX-DMM software always maintains an active link with the MTX 3283). The board therefore establishes a connection between the PC and the multimeter.



The measurement is therefore performed between pins 2 (or 3) and 5.

- pin 2: Rx Data (data reception)
- pin 3: Tx Data (data transmission)
- pin 5: chassis-earth

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Step 4

You then set the SCOPIX OX 7204 BUS oscilloscope to the type of bus to be tested. You select RS 232 at 9,600 bps and then confirm. Now you can run the diagnostic test by clicking on RUN. The duration varies according to the bus selected, the standard involved and the parameters to be measured. The wiring diagram provided on the oscilloscope helps you to connect the probe correctly.

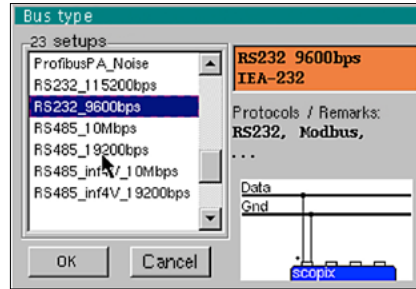
Here, the diagnostic test is performed in accordance with the IEA-232 standard (the full test takes 2 minutes). IEA-232 standardizes serial communication buses.

In the case in hand, the measurement result display in global mode is incorrect because it is 0 %. The global estimate of the bus's integrity in % takes into account all the elementary measurements.

	Min	Max	Gap
V level High	2.37 V	6.58 V	111 %
V Level Low	-5.78 V	-1.85 V	120 %
Time Data	200ns	19.6µs	---
Time Rise	---	---	---
Time Fall	---	---	---
Jitter	124.7 %	124.7 %	2494 %
Over+	6.2 %	10.1 %	---
Over-	5.9 %	9.0 %	---

Example of a result displayed on Scopix BUS (0 % in this example)

These results show that communication on the cable tested is faulty.



Example: Bus selection on Scopix BUS

Tip

The list of the various types of Bus integrated in the Scopix can be upgraded. It is very simple to modify the speed of an RS232 bus (change of time base) with the SX-BUS software just by creating a new ".BUS" setup file.

100 % ▶ A 100 % integrity measurement is displayed on a green background and indicates that all the elementary measurements are clustered around their rated values.

75 % ▶ An integrity measurement displayed on a yellow background indicates (in %) the number of correct elementary measurements in relation to the total number of measurements (this number is > 50 %).

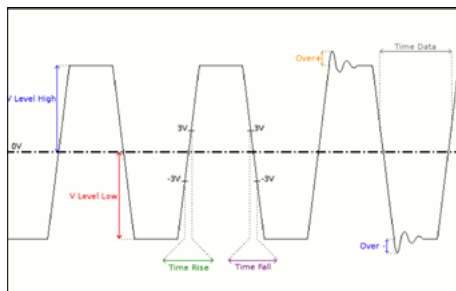
25 % ▶ An integrity measurement displayed on a red background indicates (in %) the number of correct elementary measurements in relation to the total number of measurements (this number is ≤ 50 %).

0 % ▶ A 0 % integrity measurement on a red background indicates that at least one measurement is outside the tolerance range.

If an elementary measurement has not been performed (no signal, etc.), dashes are displayed on a red background instead of a percentage. Here, we can see 2 unmeasured parameters: Time Rise and Time Fall.

Step 5

A bad result means that the measurements were either not performed or outside the tolerance range. In this case, you can directly modify the tolerances of the standard in the oscilloscope and then save them.



Example: RS 232 frame

	Min	Max	Warning
V level High	3.00 V	15.0 V	70.0 %
V Level Low	-15.0 V	-3.00 V	70.0 %
Time Data	---	---	70.0 %
Time Rise	---	4.17µs	70.0 %
Time Fall	---	4.17µs	70.0 %
Jitter	---	5.00 %	70.0 %
Over+	---	---	70.0 %
Over-	---	---	70.0 %

Example: tolerances according to the EIA-232 standard

In the results displayed above, you can see a result far outside the tolerance range, notably for the "jitter" parameter. This is the parameter which we modify in the example opposite using the stylus on the oscilloscope's touch screen.

	Min	Max	Gap
V level High	5.00 V	5.03 V	67 %
V Level Low	-3.92 V	-3.90 V	65 %
Time Data	99.6µs	1.09µs	---
Time Rise	240ns	272ns	7 %
Time Fall	1.14µs	1.30µs	31 %
Jitter	0.3 %	0.3 %	6 %
Over+	3.8 %	4.9 %	---
Over-	3.6 %	4.8 %	---

Result displayed on Scopix BUS (in this case, 80 %)

	Min	Max	Warning
V level High	3.00 V	15.0 V	70.0 %
V Level Low	-15.0 V	-5.00 V	70.0 %
Time Data	---	---	70.0 %
Time Rise	---	4.17µs	70.0 %
Time Fall	---	4.17µs	70.0 %
Jitter	---	5.00 %	100 %
Over+	---	---	70.0 %
Over-	---	---	70.0 %

Example: Modifications of jitter tolerances

Once these parameter modifications have been saved, you can rerun a diagnostic test (the filename of the modified Bus is identified by *).

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Once the results have been displayed on the oscilloscope, they can be saved in ".html" format.

BUS DIAGNOSTIC RESULT (16/12, 07:14)			
RS232 9600 bps IEA-232			
Bus quality			

Measurement	Min	Max	Error
V level High	5.01 V	5.04 V	67 %
V Level Low	-3.93 V	-3.90 V	85 %
Time Data	99.4 µs	109 µs	---
Time Rise	240 ns	256 ns	6 %
Time Fall	1.17 µs	1.28 µs	31%
Jitter	----	----	----
Over+	3.8 %	4.9 %	---
Over-	3.0 %	5.1 %	---

This file can be read in the browser of a PC connected via Ethernet or locally on the oscilloscope.



The diagnostic table below shows the main problems encountered and the probable causes. This enables a very quick initial diagnosis to target the type of action to be taken. This table is provided in an appendix to the SCOPIX BUS operating manual to guide you during your maintenance operations.

This table is also integrated into SX-BUS for more focused action.

Measurement	Description	Diagnosis
V Level High	Measurement of the signal's high level	<ul style="list-style-type: none"> Termination problem Cable length not compliant with the standard Disturbed chassis-earth problem
V Level Low	Measurement of the signal's low level	<ul style="list-style-type: none"> Significant noise (check the path of the cable, chassis-earth braid not connected, faulty chassis-earth, etc.) Etc.
Time Rise	Rise time between -3 V and 3 V	<ul style="list-style-type: none"> Cable length not compliant with the standard Bus impedance problem (the rise and fall times increase with the impedance of the cable) Etc.
Time Fall	Fall time between 3 V and -3 V	<ul style="list-style-type: none"> Etc.
Jitter	Measurement performed on the basis of the total bit times	<ul style="list-style-type: none"> Significant noise (check the path of the cable, chassis-earth braid not connected, faulty chassis-earth, etc.) Etc.
Time Data	Measurement performed on the basis of the total bit times	<ul style="list-style-type: none"> Significant noise (check the path of the cable, chassis-earth braid not connected, faulty chassis-earth, etc.) Cable length not compliant with the standard Bus impedance problem (the rise and fall times increase with the impedance of the cable) Etc.
Over-	Measurement of negative overrun	<ul style="list-style-type: none"> Unsuitable cable impedance Bus termination problem (if no termination, significant overrun)
Over+	Measurement of positive overrun	<ul style="list-style-type: none"> Significant noise (check the path of the cable, chassis-earth braid not connected, faulty chassis-earth, etc.) Etc.

After replacing the RS 232 cable, the integrity test is repeated. The values measured comply with the EIA232 standard without modifying the parameters of the standard.

Result of the measurements (16/12, 07:14)				
RS232 9600bps IEA-232				100%
	Min	Max	Gap	
V level High	7.90 V	7.94 V	18%	
V Level Low	-7.96 V	-7.92 V	18%	
Time Data	103µs	103µs	---	
Time Rise	16.0ns	48.0ns	1%	
Time Fall	16.0ns	48.0ns	1%	
Jitter	0.1%	0.1%	2%	
Over+	1.8%	2.3%	---	
Over-	1.9%	3.0%	---	

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