Digital Level Shifter for I²S Interfaces UPP-B2 and UPV-B41

Application Note

Products:

- R&S®UPP200
- R&S®UPP400
- R&S®UPP800
- R&S®UPP-B2
- R&S®UPP-B4
- R&S®UPV
- R&S®UPV-B41

This application note proposes a digital level shifter for connecting the I²S interfaces R&S®UPP-B2 and R&S®UPV-B41 to devices under test with a logic voltage different from 3.3 V.

Note:

Please find the most up-to-date document on our homepage http://www.rohde-schwarz.com/appnote/1GA71.

Application Note
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ROHDE&SCHWARZ

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1 Background

1.1 Logic voltage

Logic circuits can have different logic voltages, depending on the semiconductor technology applied. TTL circuits have 5 V logic voltage. Standard CMOS circuits usually have 3.3 V logic voltage.

1.2 I²S interface

The I²S (Inter-IC Sound) interface is as serial bus for audio data, originally specified by Philips Semiconductors (Philips Semiconductors, February 1986). The bus was introduced for digital audio connection between different ICs. It comprises one data line and two control lines (clock and word select).

Originally 5 V TTL logic voltage was specified, but the specification was planned to be extended to upcoming other logic voltages. The specification has never been extended. but in practice it is used independent of the logic voltage.

1.1 I²S interface options on R&S®UPV and R&S®UPP

For audio analyzers R&S®UPV and R&S®UPP there are I²S interface options R&S®UPV-B41, R&S®UPV-B42, R&S®UPP-B2 and R&S®UPP-B4 available.

R&S®UPV-B42 is the most versatile interface available with parameters extending far beyond the I²S functionality. This interface also provides a probe, which can be connected to the device under test with very short data lines. The probe also provides a parameter to select the logic voltage between the values 0.9 V, 1.2 V, 1.5 V, 1.8 V, 2.5 V and 3.3 V.

All other I²S interfaces on Rohde & Schwarz audio analyzers have a fix logic voltage of 3.3 V.

1.2 Pin assignments

1.2.1 UPP-B2 and UPV-B41

The pin assignments of the I²S interfaces on UPP-B2 and UPV-B41 are compatible.

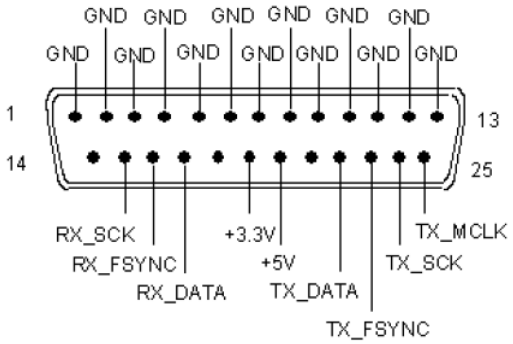

Fig. 1-1: Pin assignment of the I²S interface of UPP-B2 and UPV-B41

Therefore the same level shifter design can be used with both instruments. The exemplary implementation shown in this application note is compliant with this pinout.

1.2.2 UPP-B4

The I²S interface of UPP-B4 has four TX data lines and four RX data lines with common TX control lines and common RX control lines. It uses a 26-pin Sub-D-HD connector.

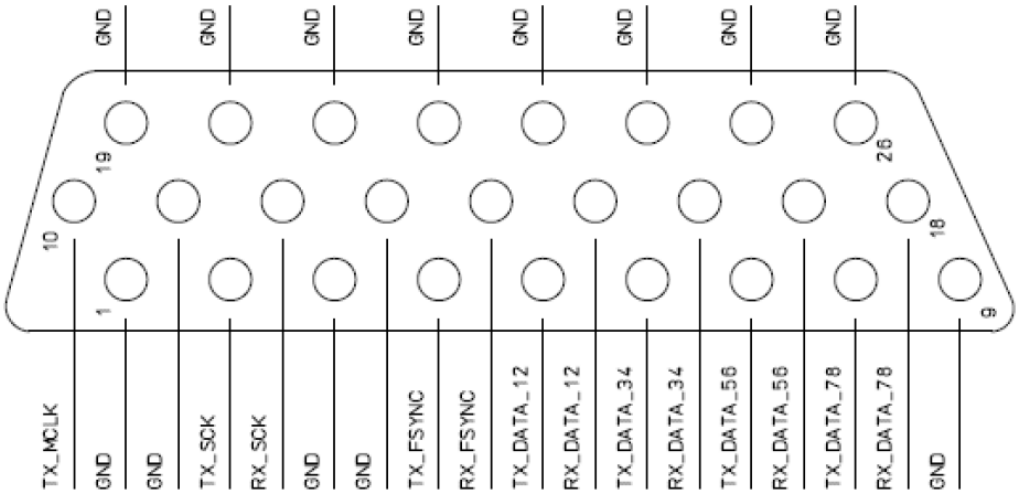

Fig. 1-2: Pin assignment of the I²S interface of UPP-B4

A level shifter with complete support for this interface requires 7 TX (high-to-low) and 6 RX (low-to-high) buffers. Consequently four pieces of the logic level shifter SN74LV4T125 are required. The design principle, however, is the same as with the circuit diagram shown in this application note.

2 Design of the Level Shifter

2.1 General

The design uses standard CMOS level shifter ICs. The circuit is powered from the 3.3 V output pin of the audio analyzer's I²S interface. The interface ICs require a supply voltage equal to the lower logic level, which is obtained using a simple low dropout linear regulator.

The level shifter buffers provide enable inputs for each buffer. When the buffer is disabled, its output has high impedance which allows to connect multiple outputs to one bus. In the present design the buffers are always enabled, as is the case with the I²S outputs of the R&S® audio analyzers.

The supply voltage inputs of the ICs and the output of the linear regulator are provided with 100 nF blocking capacitors.

The circuit allows a compact implementation, which can be installed in a Sub-D adapter case.

2.2 Bill of materials

The following is a list of required materials in addition to a printed wiring board or prototype board and some wires. The specific types are examples. Equivalent types from other manufacturers can also be used. If a logic voltage different from 1.8 V is desired, replace the low dropout regulator with an appropriate type for the desired voltage.

No.	Qty.	Designation	Type	Manufacturer
1	2	Single Power Supply Quadruple Buffer Translator GATE With 3-State Output CMOS Logic Level Shifter	SN74LV4T125	Texas Instruments
2	1	1.8 V 300 mA CMOS Low Dropout Regulator	NCV8114ASN180	ON Semiconductor
3	4	Multilayer ceramic capacitor 100 nF 16 V X7R		Murata
4	1	Sub-D connector female 25 pins		
5	1	Sub-D connector male 25 pins		
6	1	Adapter case for 25 pin D-Sub connectors	DPAK-M-25-K	encitech

Table 2-1: Bill of Materials

2.3 Circuit diagram

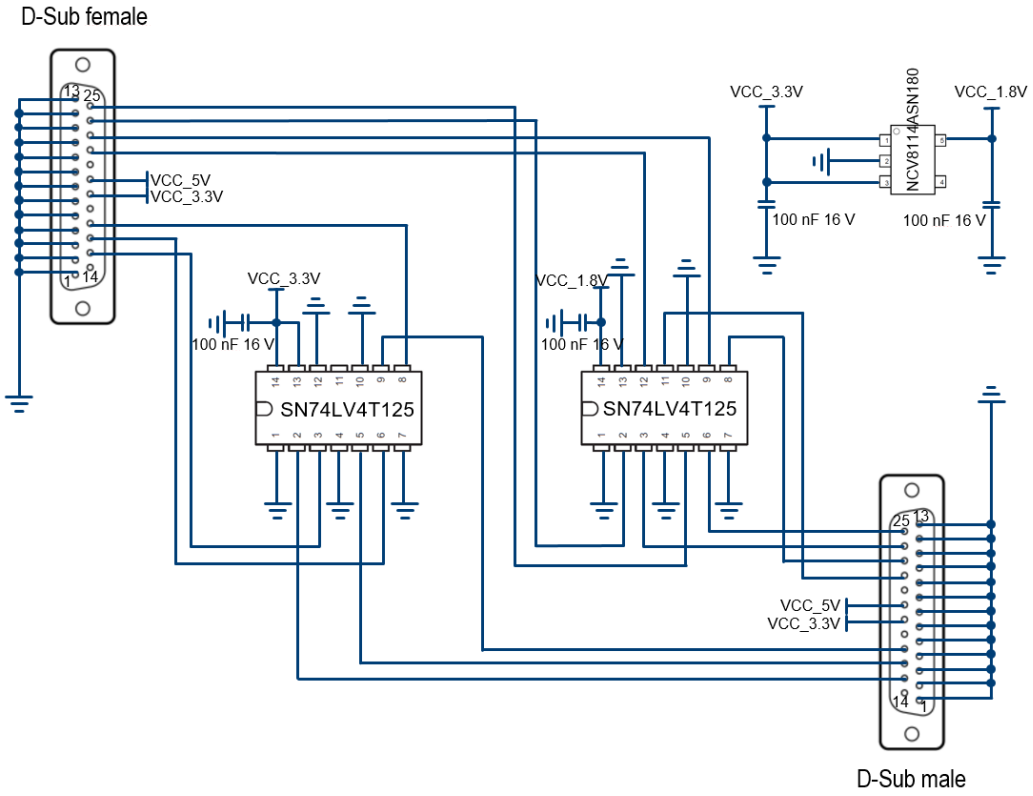

Fig. 2-1: Circuit diagram of the I²S logic level shifter

2.4 Testing

For testing it is useful to make a female connector which loops the TX data lines of the interface to the RX connections. This way the signals are converted from 3.3 V logic level to the lower logic level (e.g. 1.8 V) and back.

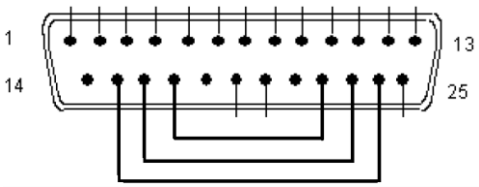

Fig. 2-2: Circuit diagram for loop test plug

Configure the I²S generator and analyzer identically, preferably at the highest available sample rate and word length. Generate a 1 kHz sine signal at 0 dBFS and check the THD+N value.

The signals at the low logic level can be tapped with oscilloscope probes to check the signal quality. For a detailed analysis of the interface signals you can make advantage of the I²S triggering and decoding software available for the oscilloscopes R&S® RTO2000, R&S® RTE1000, R&S® RTA4000 and R&S® RTM3000.

3 Literature

[1] **ON Semiconductor** NCV8114 Product Preview - 300 mA CMOS Low Dropout Regulator. - [s.l.] : Semiconductor Components Industries, LLC, December 2016.

[2] **Philips Semiconductors** I²S bus specification. - February 1986.

[3] **Texas Instruments** SN74LV4T125 Single Power Supply Quadruple Buffer Translator GATE With 3-State Output CMOS Logic Level Shifter. - [s.l.] : Texas Instruments, September 2014.

4 Ordering Information

Designation	Type	Order No.
Audio Analyzer two channels	R&S®UPP200	1411.1003.02
Audio Analyzer four channels	R&S®UPP400	1411.1003.04
Audio Analyzer eight channels	R&S®UPP800	1411.1003.08
Digital audio interfaces AES/EBU, S/P DIF, I2S	R&S®UPP-B2	1411.2300.02
Audio analyzer, analog interfaces, DC to 250 kHz	R&S®UPV	1146.2003.02
I²S interface for standard measurements	R&S®UPV-B41	1146.5402.02
I²S oscilloscope software	R&S®RTO-K5	1329.7302.02
I²S oscilloscope software	R&S®RTE-K5	1326.1210.02
I²S oscilloscope software	R&S®RTA-K5	1335.7723.02
I²S oscilloscope software	R&S®RTM-K5	5710.0882.02

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Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

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