nRF24Z1 S/PDIF connections

1. Introduction

Much existing digital audio equipment features digital interfaces. The nRF24Z1 AudioStreamer features a digital audio link. There should be no need to do AD and DA conversions where digital signals exist. This document addresses different cases where the SPDIO pin of the nRF24Z1 is connected to existing digital equipment. The nRF24Z1 can also connect via an I2S interface. This interface is not considered in this document. Please beware that the nRF24Z1 has to be configured by an external microcontroller or EEPROM to use the S/PDIF interface.

The nRF24Z1 uses the same physical pin for S/PDIF output and input. When the nRF24Z1 is used as a wireless audio transmitter (ATX) it is near an audio source, and its S/PDIF pin is an input. When it is used as a wireless audio receiver (ARX) it is near an audio destination, and its S/PDIF pin is an output.

2. Definition

S/PDIF stands for Sony Philips Digital Interface. It is a commonly used way to connect digital audio equipment. It is defined in a standard named “iec958”.

S/PDIF merges the digital data and a clock reference on the same signal. Rise and fall times in the cable and the transmitting and receiving electronics determine how well the initial clock signal can be regenerated at the receiving end. Bad rise and fall times may cause signal dependant jitter on the receiver. Because of this, keep your S/PDIF circuitry as simple as possible.

3. Typical use

There are a few places where you typically encounter S/PDIF signals.

1) Digital audio output from CD and DVD players (coax)
2) Digital audio input to HiFi amplifier (coax)
3) Digital audio output from PC (coax)
4) Digital audio output from CD and DVD players (optical)
5) Digital audio input to HiFi amplifier (optical)
6) Digital audio output from portable CD player (optical)
7) Internal connection to AC3 / DTS decoder chip

These different use cases will be explained below. Their effect on the nRF24Z1 will be emphasized.

3.1. Cases 1, 2, and 3

This is the most common way to connect S/PDIF devices. Many end customers have seen the yellow coax plugs (RCA or "phono" plug) at the back of their DVD players and amplifiers. The signal on this plug must not be confused with audio (red and white phono plugs) or composite video (yellow phono plug). On these, the signal is referred to ground inside the player or amplifier. The big difference between these signals and S/PDIF is that coax S/PDIF is isolated from the internal ground by means of a transformer. Also, the voltage level on coax S/PDIF is 0.5Vpp differential.

The cable itself has a characteristic impedance of 75Ω. Because the merged data and clock signal carried by the S/PDIF cable contains high frequencies and sharp edges, proper termination is required.

A floating, differential, 75Ω cable at 0.5Vpp doesn't easily connect to a modern CMOS chip. Therefore, a network consisting of termination, transformer, booster (usually a 7404 or comparator) and resistors is needed to convert the signal. The network for receiving S/PDIF from a coax cable is similar but not equal to the network needed for transmitting S/PDIF on a coax cable.

The nRF24Z1 demo kit uses a conversion network that can be adapted to both reception and transmission of S/PDIF. Please consult the demo kit documentation for schematic and bill of materials.

Beware that the conversion network is only needed when you have to connect to a standard S/PDIF cable. If you plan to connect to the S/PDIF output from a PC or CD/DVD player, use a conversion network at the nRF24Z1 ATX (audio transmitter). If you plan to connect to the S/PDIF input of an audio amplifier, use a conversion network on the nRF24Z1 ARX (audio receiver).

3.2. Cases 4, 5, and 6

Some digital audio sources use an optical output. The name of this signal is Toslink, where "Tos" stands for Toshiba. The main difference between Toslink and coax S/PDIF is that Toslink uses fiber optics and optical transfer of signals. That means there is a light transmitter in the Toslink connector in the CD/DVD player and a light sensitive receiver in the Toslink connector of the audio receiver.

If your product is going to interface to the optical digital output of a CD/DVD player, it will need a Toslink receiver connector at the nRF24Z1 ATX. If it connects to the optical digital input of an audio receiver, it will need a Toslink transmitter connector at the nRF24Z1 ARX.

The Toslink connectors must be chosen so that they are electrically and logically compatible with the S/PDIF input and output voltages of the nRF24Z1.

3.3. Case 7

The final case is when you want to use the nRF24Z1 to transmit compressed digital audio like AC3 or DTS.

This is typically done where multi channel decoding is performed after the signal has been transmitted wirelessly. The S/PDIF output pin from the nRF24Z1 is a CMOS signal. The S/PDIF input pin on the surround decoder may also be CMOS compatible. Then there is no need for transformers or optical devices in the signal path. The designer only has to take care that the nRF24Z1 output voltage is compatible to the decoder input voltage. A small series resistor should also be added close to the nRF24Z1 in the signal path to reduce the effects of stray capacitance and inductance.

So far, only the ARX side of a multi channel decoding product has been addressed. The ATX side (at the audio source) can be configured independently of the ARX. If the source is S/PDIF, care must be taken to design the correct interface.

The nRF24Z1 supports several formats on the S/PDIF interface. (The quoted IEC numbers are part of the S/PDIF definition which is commercially available from IEC.)

- Consumer Linear PCM Audio described in IEC 60958-3.
- Non-Linear PCM Audio described in IEC 61937-1 (General) and IEC 61937-2 (Burst-info)

When it comes to Non-Linear PCM audio, the nRF24Z1 is transparent to the specific audio compression algorithms used, so it should cover all the described formats in IEC 61937-3 to 61937-7 namely: AC-3, MPEG-1,-2 Audio, DTS, MPEG2-AAC, ATRAC and ATRAC2/3. nRF24Z1 just transfers what comes in on the input side covered by IEC 61937-2 (Burst-info) to the receiver side.

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