SoundScape Bridge (Stand Alone Digital Wireless Audio Kit)

Operation Writeup

Introduction:

The **SoundScape Bridge** VC4030TX (Transmitter) together with the VC4030RX (Receiver) is a complete system for one-way wireless digital audio transfer from an audio source to an audio recipient. A 3.5mm jack on the VC4030TX unit connects to an audio source like e.g. a CD player or MP3 player. A 3.5mm jack on the VC4030RX unit is used for connection to powered speakers

Theory of Operation:

The system is based on one-way wireless digital audio transfer from an audio source to an Audio recipient. The application consists of a VC4030TX (audio source) (ATX) in Fig 1 and an VC4030RX (audio receiver) ARX in Fig 1.

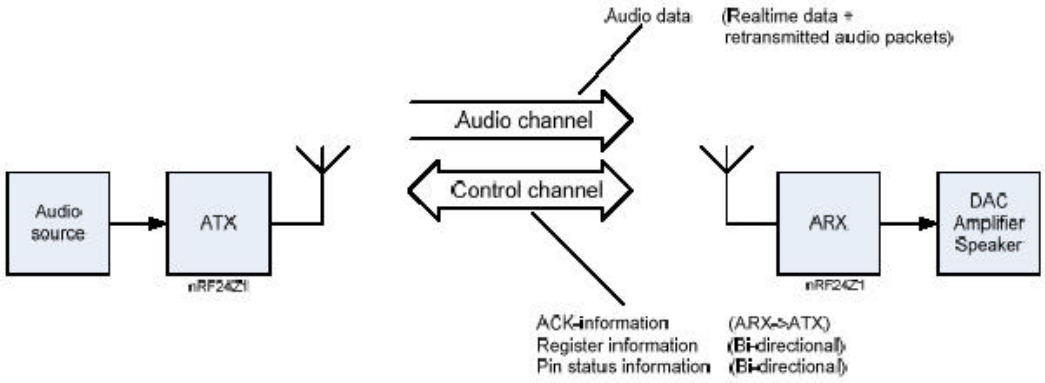

Fig 1

It is noted that communication between VC4030TX and VC4030RX are based on half-duplex transmission, where the following actions take place on a cyclic basis:

1. The VC4030TX transmits audio and control data in a data frame to the VC4030RX
(VC4030TX-Transmit, VC4030RX-Receive)

2. The VC4030RX responds to the VC4030TX with an ACK-packet
(VC4030RX-Transmit, VC4030TX-Receive)

3. VC4030RX and VC4030RX changes frequency according to AFH-algorithm

4. Step 1 thru 3 are repeated

If reception conditions are poor, the VC4030RX requests retransmission of corrupt audio data packets (their sequence number and ID is relayed back to the VC4030TX via the ACK-packet). These retransmitted packets are added to the nominal VC4030TX data frame illustrated in Fig 2.

The application is a FHSS system where only one data frame is sent at a given frequency location before hopping to the next. The cyclic period, tp (hopping rate) is 2.67ms for the 48KHz sampling rate configuration Setting.

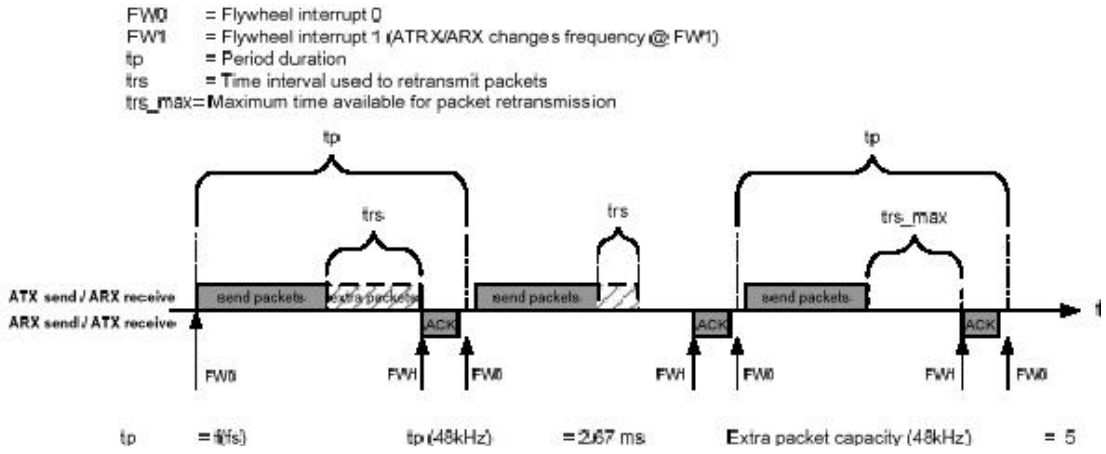

Fig 2 – SoundScape Bridge half duplex communication principle

Pseudo random properties of the embedded FHSS engine:

The embedded FHSS engine uses 38 hopping locations, out of which 18 are non-overlapping channels. The hopping sequence is contained in a table with the 38 frequency location entries staggered in a pseudorandom order (See Fig 3). A single data frame is transmitted on each frequency location before skipping to the next hopping frequency in the list. Upon completion of the list, the hopping sequence is repeated on a cyclic basis. Upon reception of faulty/no data, the frequency (ies) resulting in loss of data, is temporarily removed from the hopping sequence. The hopping sequence cycle is thus correspondingly shortened. The frequency locations resulting in loss of data are added to a list of banned frequencies containing the frequency locations unsuitable for use. This list is limited to a maximum number (NBCH), set to 0x12 in this application. The duration of the ban is given by the equation (BCHD+1) x NBCH x tp The BCHD parameter is set to 0x0A and tp is 2.91ms for the 44.1KHz sampling setting. In normal operation, the initial pseudorandom list of frequency hopping locations is volatile in terms of the number of hopping frequencies in use and the sequence of which they occur. These elements combined result in an unpredictable hopping sequence with pseudorandom properties. Hopping positions are used equally on average with even noise distribution in the band.

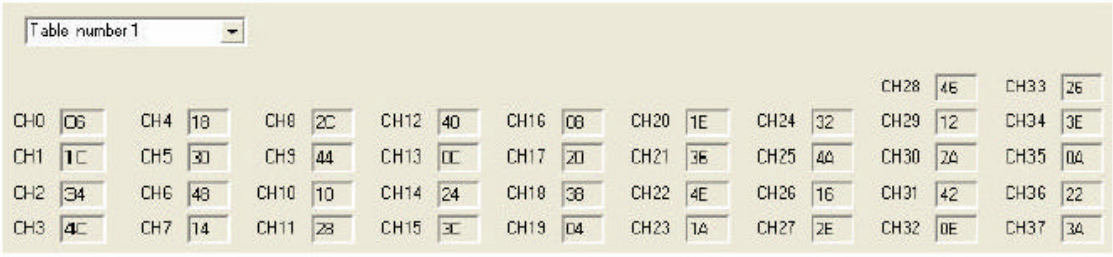

Fig 3 - Frequency hopping table example

(Actual frequency can be calculated from formula: (2.400 + CHx) [GHz])

Frequency synchronization of VC4030TX/VC4030RX units:

While streaming audio data the VC4030RX continuously sends information about the 8 next frequency positions to be used (information contained in ACK-packet). In the event of ACK from the VC4030RX being lost, the VC4030TX will know the next 7 frequencies to use. After 8 hops without ACK the communication link is lost. Upon loosing link, communication is re-established by the VC4030RX entering receive-mode at a fixed channel for a given duration. The VC4030TX transmits link-locate packets expected by the VC4030RX. The link-locate packets are transmitted at each of the frequencies used in the hopping sequence. Upon reception of a link-locate packet, the VC4030RX transmits an ACK-packet to the VC4030TX, re-establishing the audio link.

Device Adaptation to RF Environment:

In an environment without other 2.4GHz applications or noise sources, the nRF24Z1 will use all the frequency positions listed in Fig-3. In the presence of an active RF system, occasional packet collisions are likely, resulting in RF packets being lost.

When an operating frequency resulting in unacceptable packet loss is detected, the ATX removes it from the list of frequency positions used by AFH algorithm. The corresponding list in the ARX is synchronized by use of the control channel.

Frequency positions removed from the frequency hopping sequence are added to a list of frequencies temporarily banned for use by the AFH-algorithm.

The length of the list of banned frequencies, and the duration of the ban, are configurable

The maximum number of banned channels are 18. The frequency positions are equally distributed over the available frequency bands.