KleerNet is a complete hardware and software solution that enables wireless audio in home and portable CE products and features interoperability across products and brands. KleerNet-compatible products allow users to recognize and pair with other KleerNet products to access and stream multiple music sources, speakers or headphones, creating a versatile and comprehensive platform. SMSC has leveraged seven generations of our proven, DARR high-performance wireless audio technology, successfully deployed in many consumer products worldwide, with extensive application software development to create the robust and interoperable KleerNet application. The KleerNet software platform provides high-quality, uncompressed, low-latency, multi-channel wireless audio that supports a wide variety of applications in the PC, gaming and home audio markets. Reference modules are readily available in multiple form factors to simplify system integration and product development. The same transceiver module can be used as either the source (transmitter) or speaker (receiver), depending on the software configuration. An SDK and graphical user interface reference package for PCs is also available, enabling simple software implementation and system development for PC audio streaming applications.

Designing with KleerNet

To significantly accelerate product development, we highly recommend customers use our standard evaluation kit, pre-programmed with a software suite of pre-defined applications. These applications cover more than 90% of the most common use cases. Further customization is possible, which designers can easily develop. “C” programming language is used for software development and the default software environment tool is the IAR Embedded Workbench for 8052 MCU.

The basic evaluation kit (EVK) consists of a Transmitter unit (Tx) and a Receiver unit (Rx). Every EVK is both a transceiver and software programmable to perform either as a Tx or an Rx. Please refer to the EVK startup manual for additional information. Additional EVKs (as receivers) can be ordered to increase and extend the use case functionality beyond a single transmit/receive pair. For example, to design a complete a 7.1 channel wireless audio system, nine EVKs (one Tx and eight Rx’s) would be used. The EVK also interfaces with different KleerNet-supported reference designs and modules. Any module can be made to work with the EVKs.

Target Applications

- Home Theater Systems
- 5.1 and 7.1 Speaker Systems
- Soundbars and Sub-woofers
- Headsets and Headphones
- Gaming Headsets
- Wireless Rear Speakers
- Remote Controllers
- PCs and Media Devices
- Televisions

KleerNet Protocol Description

The chart below provides a high-level overview of the KleerNet protocol. The protocol implementation is defined by three major sections:

1. The RF layer that establishes the radio communication link between audio devices/products
2. The PHY and audio/data link layer
3. The network management and SDK API layer
KleerNet Protocol Tasks and Functions

<table>
<thead>
<tr>
<th>Task</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Discovery</td>
<td>Allows a receiver (Rx) to find a source or transmitting (Tx) device</td>
</tr>
<tr>
<td>Node Discovery</td>
<td>Allows the Tx to find available Rx’s</td>
</tr>
<tr>
<td>Pairing</td>
<td>Rx and Tx exchange functionalities and capabilities, including supported network functions (audio source/audio receiver)</td>
</tr>
<tr>
<td>Network Configuration</td>
<td>Given a defined set of nodes and a desired network structure, the Tx will automatically configure the network to the desired network structure</td>
</tr>
<tr>
<td>Network Management</td>
<td>The network is maintained (link quality monitoring, addition of extra nodes, etc.) and re-configured, as needed</td>
</tr>
<tr>
<td>Standardized User Functions</td>
<td>Typical audio features supported through a standardized messaging protocol for remote control functionality (Play/Pause/Mute/FF/REW/Volume Up/VOLUME Down/Playlist, among others)</td>
</tr>
</tbody>
</table>

Each node discovery task is identified by a unique, 24-bit code which remains unchanged during operation and power down. The stack runs on an embedded MCU processor in both the DARR83 and DARR84, as well as future roadmap ICs. Beacon (or short burst) packets are transmitted once every 75ms and carry KleerNet and processor information to initiate and perform data exchanges during normal operation and standby modes. They are used to initiate, accept or reject connectivity between neighboring audio devices based on the information exchanged during the network discovery and selection phase. This provides increased flexibility to acknowledge and/or reject connections by both the Tx and Rx. When multiple Tx’s are present, the Rx has the option and flexibility to join whichever network it prefers. After selecting the desired Tx and Rx pair, the following critical information is exchanged during the node inventory phase:

1. KleerNet software  
2. Target number of streams that an Rx can support  
3. Applications supported: pre-defined applications reside in the renderer  
4. Brand, product type and product ID  
5. Audio settings: sampling rate, resolution and audio bit rates  
6. Renderer functions: audio stream/channel configuration, among others

After the above information has been exchanged, the Tx will share its network ID and connect code to initiate the pairing process with the selected Rx’s. A pairing process is required when the Tx and Rx are connected for the first time. Once paired, each audio device will store this information in its memory until removed by user initiation. Finally, the network can be configured and maintained for general housekeeping functions such as user zones and maintaining Quality of Service (QoS), among others.

Wireless DNA Detect ‘n Avoid Architecture

SMSC’s Wireless DNA technology effectively manages common interference sources such as Wi-Fi®, BlueTooth® and microwave ovens.
Platform Features

- Audio processors and software
  - DARR83 and DARR84 processors
  - KleerNet software

- KleerNet protocol functions
  - Network and node discovery
  - Pairing and node inventory
  - Network configuration and management
  - Stream from PCs and media devices

- KleerNet differentiating features
  - Low latency < 20 ms
  - Multi-RF band support
  - Uncompressed audio
  - Supports 7.1 wireless systems
  - Whole home range ~50m indoors

- Easy-to-use, customizable GUI
  - Scans/lists sources and sinks
  - Lists status of paired devices
  - Supports/manages audio zones

- Broadcast/Party Mode
  - Streaming home stereo audio
  - Supports up to 12 receivers
  - Synchronized music streaming
  - Synchronized multi-zone streaming (party mode)

- Multi-zone Mode
  - Streaming audio in home or room
  - Create up to four different zones
  - Each zone delivers different music
  - Optionally supports 7.1 within room

- KleerNet remote functions
  - Play/Pause/Mute/FF/REW
  - Volume Up/Down

- KleerNet control functions
  - Audio source selection
    (Aux/phone, etc.)
  - Album, song title, album art
  - Elapsed time, Playlist
  - Manages playback modes
  - Wireless transfer of speaker images
  - Source and zone selection by speaker

- KleerNet background monitoring features
  - Link quality monitoring
  - RF channel and band scanning
  - Continuous scanning for new devices
  - HID and metadata communication

Evaluation Board Features

- Inputs and outputs
  - 4 pairs of analog inputs/outputs
  - Supports 4 I²S digital inputs/outputs
  - Supports 2 digital S/PDIF inputs/outputs
  - Microphone interface for voice

- Operating power supply
  - Supports 5.0V
  - Supports 5.0V USB power

- Clocks, LED and GPIO support
  - 12.288MHz
  - RF link/channel LEDs
  - Configurable GPIOs through GUI

- Module interface support
  - FFC (Flat Foil Cable)
  - Pin header

- Performance and range
  - 50m indoor range at 2.4GHz
  - 30m indoor range at 5GHz

- Audio codec
  - Dedicated codec for each audio input
    or output channel
  - MIC-in jack available for headset
    applications
**Application Examples**

**Party (Broadcast) Mode:** In this mode, all speakers/renderers will play the same music source from the main Tx in the entire home.

- Pairs all speakers together to the source: PC, USB, DVD
- Selects the music from the Playlist (iTunes®/Windows Media Player®/internet radio)

**Multi-Zone Mode:** In this mode, all speakers/renderers will have the option to select music and associate with one of four zones. Each zone is able to play different music.

- Pairs all speakers together to the source: PC, USB, DVD
- Creates up to four music zones; each zone can have multiple speakers streaming different music.
**Headset Mode:** In this mode, Skype™ communication can be held in tandem with music being streamed onto other modes.

- Pairs all speakers and headsets/earphones to source
- Initiates or receives Skype calls while listening to music

**Wireless Mode with Separate Stereo:** In this mode, a system is configured for a complete 5.1 wireless mode with an optional stereo stream mode for headset use. Alternatively, product designers can extend the number of wireless speakers to seven as well as configure as a wireless 7.1 speaker system.

- 5.1 channel from Windows Vista®/Windows® 7 or DVD/AMP
- Streams up to six speakers from PC
- Also supports a single stereo stream to a headset or second speaker
KleerNet Graphical User Interface (GUI)

The sample KleerNet GUI pictured can be used as a reference for development and promotional purposes. The GUI has the ability to assign and control the different user application scenarios that have been discussed in the previous section. The left column indicates the supported music sources that can be replaced by sources such as Pandora® and Windows Media Player, among others. The top right section lists the receivers/speakers in different locations of the house that are paired to the KleerNet transmitter. The bottom right section indicates all of the available speakers that are not currently paired in the system.

KleerNet Modules/Reference Designs

The following tables can be used as a reference when designing KleerNet-based wireless audio systems

### DARR83/DARR84 Reference Modules Supporting KleerNet

<table>
<thead>
<tr>
<th>Feature</th>
<th>DWUSB83</th>
<th>DWAM83</th>
<th>DWHP83</th>
<th>DWPCIe83</th>
<th>DWHS84</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>2.4, 5.2, 5.8GHz</td>
<td>2.4, 5.2, 5.8GHz</td>
<td>5.2, 5.8GHz</td>
<td>2.4, 5.2, 5.8GHz</td>
<td>2.4, 5.2, 5.8GHz</td>
</tr>
<tr>
<td>Audio Streams</td>
<td>Up to 4</td>
<td>Up to 4</td>
<td>Up to 4</td>
<td>Up to 4</td>
<td>Up to 2</td>
</tr>
<tr>
<td>Audio Resolution</td>
<td>16-bit, 48KHz</td>
<td>16/24-bits, 48/96KHz</td>
<td>16/24-bits, 48/96KHz</td>
<td>16/24-bits, 48/96KHz</td>
<td>16/24-bits, 48/96KHz</td>
</tr>
<tr>
<td>Bi-directional Audio</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
</tr>
<tr>
<td>Antenna</td>
<td>Uses PCB antenna</td>
<td>Uses PCB antenna</td>
<td>Uses PCB antenna</td>
<td>Supports IPEX antenna connector</td>
<td>Uses PCB antenna</td>
</tr>
<tr>
<td>Antenna Diversity</td>
<td>Not applicable</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
</tr>
<tr>
<td>On-board Memory</td>
<td>1 Mbit</td>
<td>1 Mbit</td>
<td>1 Mbit</td>
<td>1 Mbit</td>
<td>1 Mbit</td>
</tr>
<tr>
<td>Input Voltage</td>
<td>5.0V</td>
<td>3.3V</td>
<td>3.3V</td>
<td>3.3V</td>
<td>3.3V</td>
</tr>
<tr>
<td>Connector Interface</td>
<td>USB</td>
<td>FFC 26-pin</td>
<td>Pin header</td>
<td>26-pin standard, mini PCI express card edge connector. Uses USB pins for audio and data communications</td>
<td>Not Needed</td>
</tr>
<tr>
<td>Size</td>
<td>18mm x 44.5mm (w/o USB connector)</td>
<td>35mm x 35mm</td>
<td>40mm x 20mm</td>
<td>Mini-PCIe specification</td>
<td>54.7mm x 54.5mm</td>
</tr>
</tbody>
</table>

SMSC is committed to working toward a sustainable environment. We endeavor to make continual improvements in natural resource conservation through efficient product design and global operations thereby reducing greenhouse gas emissions generated by our products and facilities. Our environmental life cycle process seeks to reduce our carbon footprint through product life and recyclability and efficient use of materials, energy and transportation. We remain committed to promoting smart energy policies across our global organization.