AN0622

CS2500, CS2501, and CS2600 for Automotive Audio Networks

Introduction

The CS2500, CS2501, and CS2600 clock multiplier devices are ideally suited for use in high-fidelity audio subsystems within automotive applications. This document describes typical automotive audio networks, and the benefits which these clock-multiplier devices can offer.

Table of Contents

1 Automotive Audio Networks

The need for time-synchronized automotive networks is driven by growing demand for audio and video features such as ADAS, remote amplifiers, navigation, and rear-seat entertainment. Traditional solutions require expensive and complex cabling. Different network solutions have emerged for use in automotive applications, the most common currently being AVB and A2B.

1.1 AVB Networks

Audio Video Bridging (AVB) is built around the open suite of ethernet standards. It provides time synchronization and transport protocol enabling the network to handle time-sensitive audio-visual data.

The AVB network leverages the existing ethernet hardware and software ecosystem, and adds the high-reliability, flexibility, and precise time synchronization required by audio applications.

AVB achieves precise time synchronization using the IEEE 802.1AS Precision Time Protocol (PTP). The PTP protocol is distributed and specifies how the real-time clocks in the system synchronize with each other. The manager clock establishes the reference time for the network; synchronization is achieved by time-stamping packets as they leave the manager and as they arrive at each peripheral node.

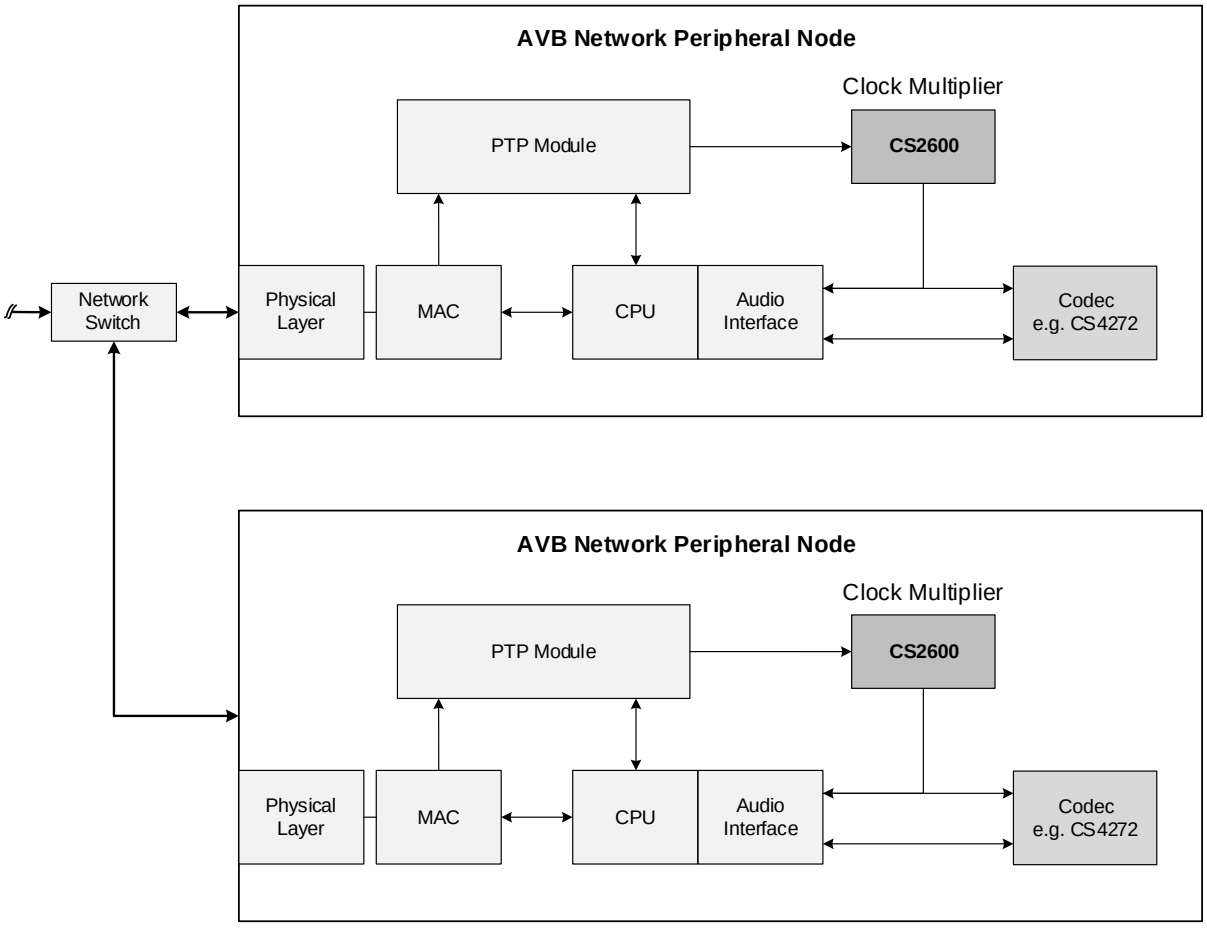

Figure 1 AVB Network

The PTP clock generally operates at low frequency and has poor jitter characteristics. The CS2500, CS2501 and CS2600 devices can provide the high-frequency, low-jitter clock required by high-fidelity audio converters, frequency-locked to the PTP clock reference.

1.2 A2B Networks

Automotive Audio Bus (A2B) is a proprietary technology developed by Analog Devices that enables an in-line topology, comprising a manager device and up to 10 peripheral nodes. The A2B network enables high-speed low-latency data communications for automotive applications.

Connectivity is supported using an unshielded twisted pair (UTP), with a data rate of up to 50 Mbps. The distance between nodes can be as long as 15 m; the maximum network length is 40 m.

The bus supports bidirectional communications (32 channels, up to 24 bits). The network ensures the latency to each node is lower than two audio-sample periods; the latency can be compensated for in each node, supporting latency-sensitive applications such as noise cancellation.

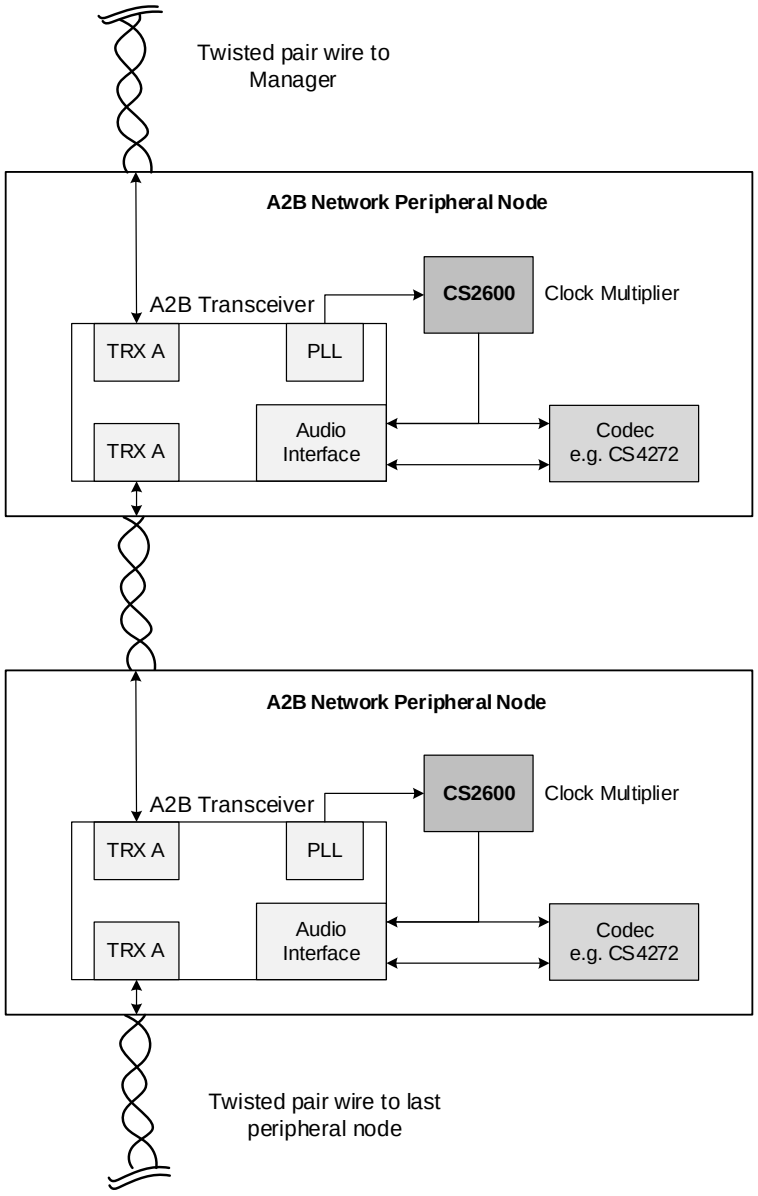

Figure 2 A2B Network

The A2B network transports synchronous audio data. Peripheral transceivers generate their own audio clocks, but this is dependent on the network being stable. In the event of the network being interrupted, the clock generation is compromised, together with all downstream digital components being clocked from it.

The CS2500, CS2501 and CS2600 devices can provide robust low-jitter clocks for digital audio applications. They can synchronize with the network (when available) and can maintain the output clock in the event of the network being interrupted. The devices can also provide a stable clock before the network is running, allowing subsystems to be initialized earlier and reducing the start-up time for audio functions.

2 Clock Timing Solution

For all types of in-car network, the quality of the clock for high-fidelity audio applications is of crucial importance. The CS2500, CS2501 and CS2600 devices are ideal companion clocking ICs for the network peripheral nodes, providing a reliable clock with low phase noise in the audio band, enabling optimal performance of the attached audio converters. The local clock for each node can be maintained at all times, including when the network is disabled or interrupted.

The CS2500 and CS2501 (drop-in replacements for CS2000, CS2100, CS2200 and CS2300), are optimized solutions for generating high-quality low-jitter clocks that are frequency-locked to the network reference.

The CS2600 provides additional features and enhancements, including the ability to generate local digital-audio clocks that are fully synchronized from one node to another. The CS2600 has been designed to be a high-performance timing solution for current AVB and A2B networks.

2.1 Design Architecture

The hybrid analog/digital PLL architecture enables the generation of output clocks that are frequency related (through a configurable ratio) to the reference signal retrieved from the network. Low jitter is ensured using a locally generated timing reference (crystal or integrated LC oscillator).

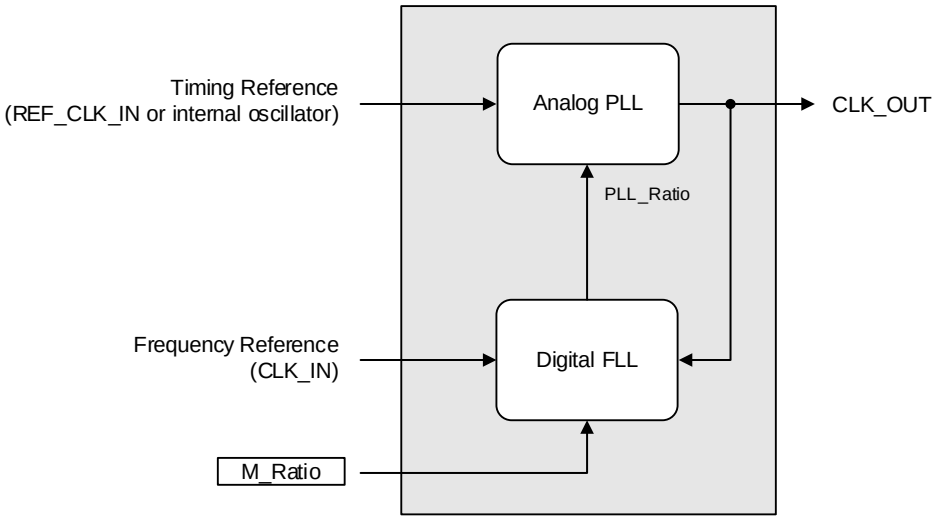

Figure 3 Design Architecture

2.2 Stable Clock Output

The CS2500, CS2501 and CS2600 devices can provide a stable clock output, regardless of the network status, and can seamlessly re-lock to the network reference when it is present and stable. The ability to maintain a stable clock during network interruptions, including before the network has initialized, means the audio functions in each network node can be supported at all times.

The hybrid PLL architecture ensures a high-quality, low phase-noise clock output through all operating conditions. In the event of the network being interrupted, or other degradation of the frequency reference, the PLL free-runs autonomously until the reference is restored.

2.3 Configurable Multi-Output

The CS2600 provides three clock outputs. In addition to the main clock output, two further clocks, BCLK_OUT and FSYNC_OUT, are derived from the main clock output to support digital-audio applications.

The BCLK and FSYNC outputs support configurable divider ratios and can be phase-aligned to the clock input. Clock-stop logic ensures all outputs are stopped at valid frame boundaries, referenced to the audio-data format.

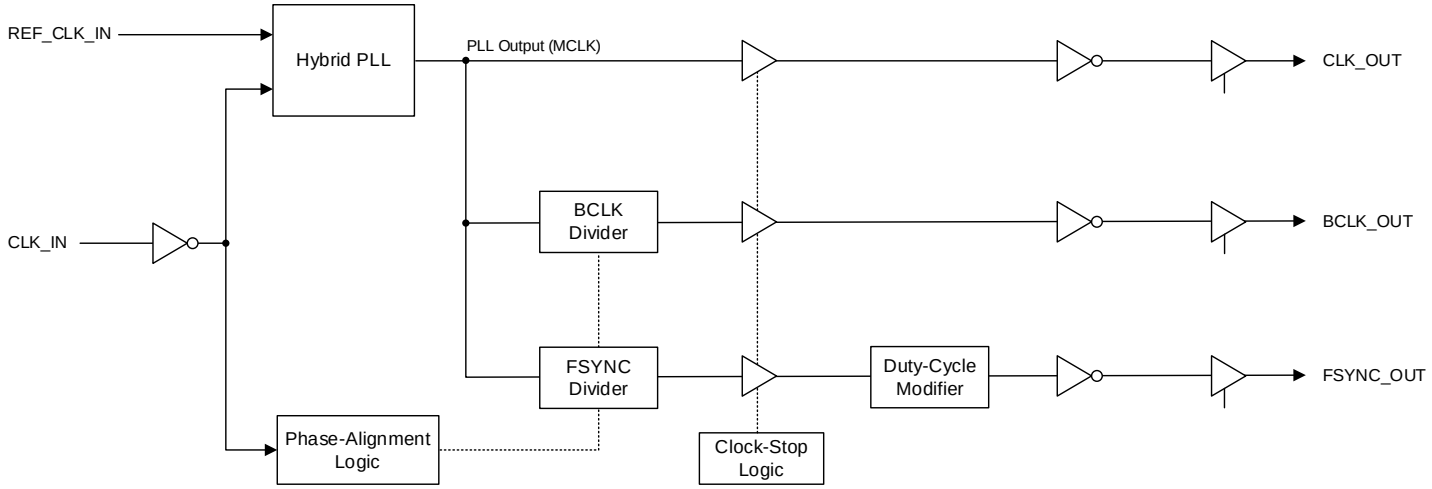

Figure 4 Clock Outputs

2.4 Multi-Node Synchronization

The CS2600 incorporates phase-alignment logic for the BCLK and FSYNC clock outputs. The benefit of this feature is that, in addition to being frequency aligned to the network clock, these outputs are also synchronized with the network and hence with the audio data that is transported.

Using the same phase-alignment logic in all peripheral nodes, synchronized local audio clocks can be generated in multiple nodes simultaneously, all of them referenced to the same network source. The clock outputs are re-synchronized automatically if necessary.

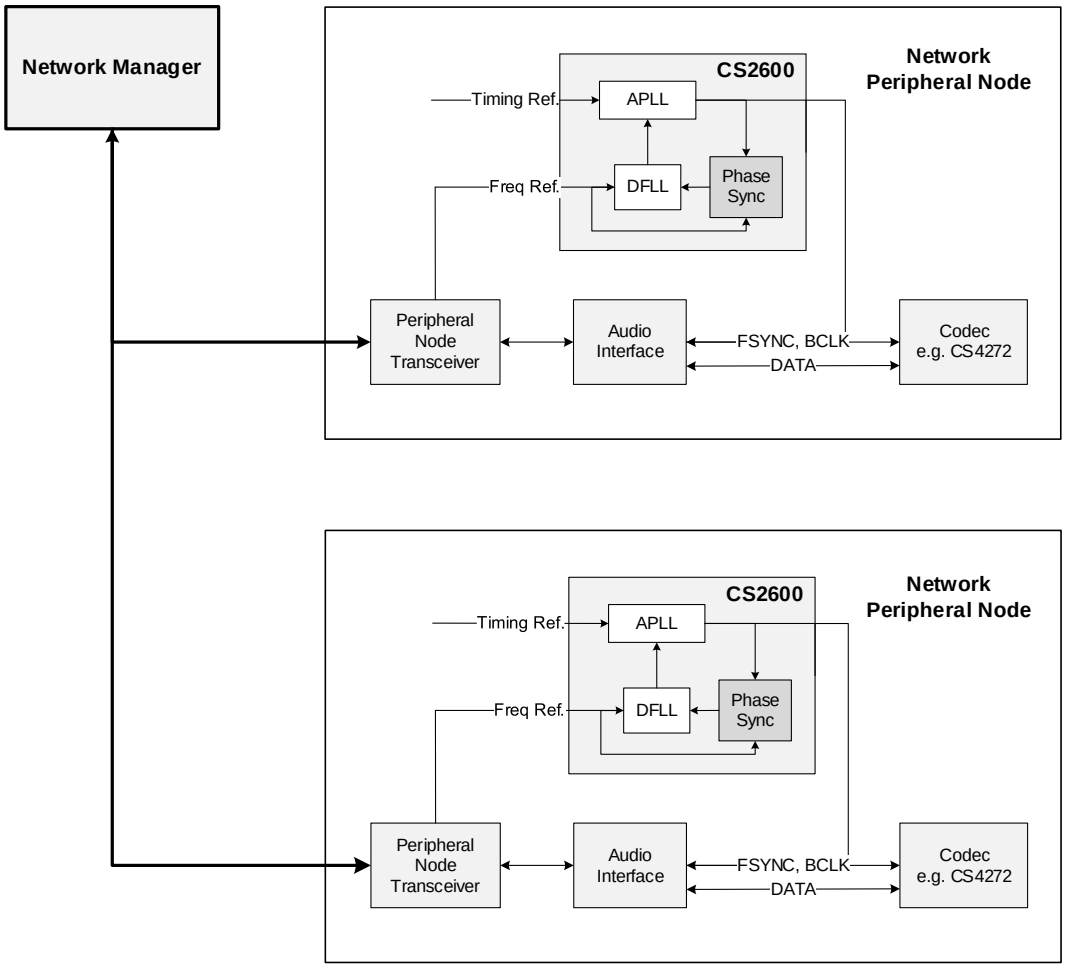

Figure 5 Multi-node Synchronization

2.5 Hostless Configuration and Bootup

To reduce the software overhead of the network manager or local controller, the CS2600 can be configured without the need for a host device. Common settings can be configured using hardware-control pins, or the device can be fully customized using integrated OTP memory.

The hostless operation provides a simple solution that is quick to boot up and can support clock generation before the host is running.

2.6 Automotive Grade

The CS2500, CS2501 and CS2600 devices are qualified to automotive standard AEC-Q100 Grade 2.

2.7 Summary

The CS2500, CS2501 and CS2600 devices employ a novel hybrid-PLL architecture to generate stable low-jitter clocks. The devices provide an ideal and cost-effective clocking solution for the most popular automotive audio networks, enabling downstream audio-data converters and digital-audio amplifiers to maximize their performance in high-fidelity applications.

3 Feature Summary

The CS2500, CS2501 and CS2600 devices support feature sets as summarized in Table 1. Note that the CS2500 and CS2501 provide equivalent functionality; the two variants exist as drop-in replacements for discontinued legacy products.

Table 1 Feature Summary

Device	Stable clock output	Multiple outputs	Multi-node synchronization	Hostless configuration
CS2500 / CS2501	Yes	No	No	No
CS2600	Yes	Yes	Yes	Yes

4 References

- A2B and Ethernet in Automotive Applications: What, When and How, https://www.analog.com/en/resources/technical-articles/a2b-and-ethernet-in-automotive-applications-what-when-and-how.html
- Institute of Electrical and Electronics Engineers (IEEE), 1588-2008 - IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems, http://www.ieee.org/
- Institute of Electrical and Electronics Engineers (IEEE), 802.1AS-2011 - IEEE Standard for Local and Metropolitan Area Networks - Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks, http://www.ieee.org/
- Institute of Electrical and Electronics Engineers (IEEE), 802.1BA-2011 - IEEE Standard for Local and metropolitan area networks--Audio Video Bridging (AVB) Systems, http://www.ieee.org/

5 Revision History

Revision History

Revision	Changes
R1 MAR 2024	• Initial Release

Contacting Cirrus Logic Support

For all product questions and inquiries, contact a Cirrus Logic Sales Representative.
To find the one nearest you, go to www.cirrus.com.