T30HM1TS2500
PLCA Coordinator Redundancy

AND90416/D

Introduction

This application note describes a coordinator redundancy mechanism for 10BASE-T1S multidrop Ethernet networks. This method improves availability and fault tolerance in automotive and industrial systems by preventing communication disruption when a PLCA coordinator temporarily fails. The approach is hardware-based, standards-compatible, and requires no software intervention.

Theory of Operation

Physical Layer Collision Avoidance (PLCA) ensures orderly access to the shared medium by allocating transmission opportunities in a round-robin manner. A coordinator signals the start of each arbitration cycle.

If the coordinator is reset or temporarily unavailable, PLCA operation halts until the network falls back to a less efficient collision detection method (CSMA/CD). This results in latency spikes and reduced throughput.

Figure 1 shows the result of a simulation with minimum length frames and up to eight stations concurrently using the medium in CSMA/CD vs PLCA operation.

It can clearly be seen that this situation causes a drop in usable bandwidth of around 40% can occur when the segment falls back to CSMA/CD. Note that longer frames and more stations worsen that situation.

CSMA/CD vs. PLCA (minimum length frames)

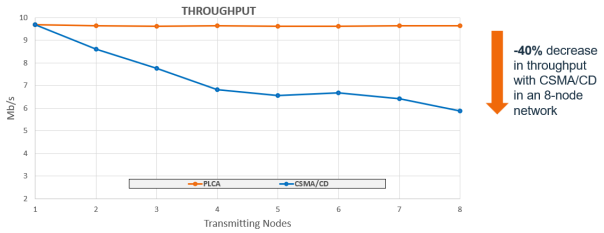

Figure 1. PLCA vs. CSMA/CD Usable Bandwidth

Coordinator redundancy, implemented in **onsemi**'s 2nd generation 10BASE-T1S MAC-PHY T30HM1TS2500, allows one or more follower nodes to be configured to detect missing BEACONs. These nodes remain inactive during normal operation and automatically provide a replacement coordination signal if the primary coordinator fails.

This technique eliminates arbitration downtime, avoids protocol fallback, requires no host involvement, and introduces only microsecond-scale timing impact. The mechanism is fully compatible with IEEE 802.3cg and does not alter standard frame formats or timing requirements.

PLCA Coordinator Redundancy significantly improves the robustness and availability of 10BASE-T1S networks, making them better suited for safety-critical and availability-driven automotive applications.

Mode of Operation

To configure a T30HM1TS2500 MAC-PHY device as a redundant coordinator, a simple write operation to two registers is sufficient.

The redundant coordinator must be given the same Node Count information as the primary coordinator for which it provides redundancy.

Once configured, the redundant coordinator can detect a missing BEACON within as little as one additional Transmit Opportunity.

A redundant coordinator will provide a replacement BEACON if it detects a Transmit Opportunity whose number equals its own Node ID plus the maximum Node Count.

For example, in a network segment with a Node Count of 8 and the redundant coordinator is configured to Node ID = 1, the device will generate and transmit a replacement BEACON if the Transmit Opportunity exceeds "9".

Under normal operation (that is, when the primary coordinator is operating correctly), a Transmit Opportunity of "9" cannot occur because the coordinator resets the PLCA cycle at the end of Transmit Opportunity #8.

A redundant coordinator will remain silent as long as the primary coordinator resets the PLCA cycle at the correct time.

If no BEACON is detected during start-up, the redundant coordinator will temporarily assume coordinator functionality.

This mechanism operates without upper-layer (software) intervention by a host. However, the redundant coordinator can be configured to signal a BEACON takeover by triggering an interrupt to a connected host MCU or computer.

Host software may respond to this interrupt and signal a fail-safe state to the overall system (outside the scope of this application note).

Configuring PLCA Coordinator Redundancy in T30HM1TS2500

As described above, the T30HM1TS2500 needs to be configured to take over the PLCA Coordinator Redundancy (PLCA/CR) function:

Set Node Count in the PLCACTL1 register (see datasheet for details).

Set bits [15:8] (NCNT) to the same Node Count value that is used by the primary coordinator.

The final step is to enable the PLCA/CR function in the PLCAEXT register (MMS 4, address 0x8002) by setting bit #2 to “1”.

This enables PLCA coordinator redundancy, and no further host intervention is required.

The function remains in a “watchdog” state until the device detects a missing BEACON condition. It then provides replacement BEACONs and returns to the watchdog state when another station sends valid BEACONs before the Node ID + Node Count condition is met.

Enable Interrupt Notifications

To be notified of an active PLCA coordinator redundancy situation (that is, the redundant coordinator is actively sending replacement BEACONs), bit #6 of the MIIMRQM (MIIM interrupt mask register) at MMS 12, address 0x0010, must be changed from its default state (1) to a value of 0.

When an interrupt is triggered by the T30HM1TS2500, the connected host can read the MIIM IRQ status register (MMS 12, address 0x0011). If the host finds bit #6 set in that register, it should also check bit #4 of the PLCAEXT register for the redundant coordinator status.

When the coordinator redundancy function is sending BEACONs, this bit reads 1, indicating that the network PLCA coordinator (Node ID = 0) failed to provide a BEACON and is therefore not functioning properly (redundant coordinator in PLCA protection mode). When bit #4 of PLCAEXT reads 0, it indicates that the network PLCA coordinator (Node ID = 0) has resumed normal operation and is providing BEACONs for the PLCA-enabled multidrop segment (coordinator redundancy either disabled or in armed mode) after having missed at least one BEACON at the end of a PLCA cycle.

Building a Cascade of Redundant Coordinators

The redundant coordinator triggers on the Node ID + Node Count condition.

Up to 127 redundant coordinators can be present on a segment (although other 10BASE-T1S limitations typically reduce this number).

If they are configured with the same Node Count value, redundant coordinators will act in priority order based on their PLCA Node IDs.

This means that if a redundant coordinator with Node ID = 1 also fails, the redundant coordinator with Node ID = 2 will provide replacement BEACONs one Transmit Opportunity later.

The latency penalty is an extra Transmit Opportunity timeout (3.2 µs typical) per additional redundant coordinator becoming active.

Conclusion

PLCA Coordinator Redundancy significantly improves the robustness and availability of 10BASE-T1S networks, making them better suited for safety-critical and availability-driven automotive applications.

REVISION HISTORY

Revision	Description of Changes	Date
0	Initial document release.	4/28/2026

ADDITIONAL INFORMATION

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