

Design Guide for Automotive Ethernet Systems Supporting Both TC10 and Non-TC10 Sleep Modes on a Single Platform



Frank Qin

This document was translated from a simplified Chinese source. ([ZHCTA07](#))

Highlights of hardware implementation and software collaboration based on TI's DP83TC812R-Q1

1. Why is it necessary to be compatible with both TC10 and non-TC10?

With the large-scale adoption of 100BASE-T1 in the automotive sector, a growing number of systems require supporting both TC10 Remote Sleep/Remote Wake (IEEE 802.3bw-2015) wake/sleep and traditional non-TC10 sleep (Power-Down/Standby/host-controlled shutdown).

The following scenario is common in real-world projects where ECU needs to interface with some TC10-enabled peer devices (cameras, displays, ADAS modules...), but the same platform may also be compatible with non-TC10 peer devices. The system sleep policy may originate from the vehicle's power management system rather than the peer end of the link. Consequently, some OEMs require that it must be capable of entering sleep mode regardless of whether TC10 is enabled, and must support complete disconnection of PHY's main power supply (supply cut-off).

Therefore, a PHY chip must support both TC10 Sleep and traditional sleep mode across different vehicle models/peer ends/configurations, presenting challenges for hardware design and software strategies.

In this paper, TI DP83TC812R-Q1 is used as an example to provide a directly implementable and universally compatible system solution.

2. Core difference between TC10 and non-TC10 sleep mode

2.1 TC10 Sleep (Remote Sleep/Remote Wake)

DP83TC812's TC10 work flow is summarized below:

1. Peer end initiates LPS (Low Power Sleep) request;
2. The local end enters Sleep Ack status;
3. If MAC/system allows entry into TC10 → PHY into TC10 Sleep status;
4. In TC10 Sleep status:
 - INH pin becomes Hi-Z (Externally pulled down to control LDO shutdown)
 - VDDA/VDDIO/VDDMAC is cut off
 - VSLEEP remains powered at 3.3V, responsible for MDI wake detection
5. Local WAKE or remote WUP → INH is pulled high again → LDO is turned on → PHY is powered up again

This is a standardized and automatically controlled sleep mechanism.

2.2 Non-TC10 Sleep (Traditional Sleep)

When TC10 is not enabled, PHY does not execute the TC10 state machine; INH remains high and is not used to shut down the main power supply; sleep control is software-based in conjunction with PMIC.

The available options are listed as follows:

Mode	Control Method	Characteristics
IEEE Power Down	Configure BMCR.PD	PHY enters low-power mode while remaining powered
Standby	Soft control or system logic	Low consumption, power supply maintained
Host-controlled power cut-off	MCU pulls LDO EN low	PHY is completely powered down and does not rely on TC10

This is a purely system-defined sleep mechanism.

3. Factors to be considered on hardware if the system needs to support both TC10 and non-TC10

3.1 VSLEEP power must be reserved

Purpose of VSLEEP:

- To maintain ultra-low-power monitoring on MDI side during TC10 Sleep state;
- To maintain power for WAKE/WUP logic;
- Provides the necessary power supply support for the internal logic of the INH.

Even when TC10 is not used, it is still possible to:

- Keep VSLEEP powered at all times (current in μA level);
- The system retains full discretion to choose whether to enter TC10 Sleep.

Therefore, VSLEEP is a low-cost configuration option that provides maximum compatibility.

3.2 INH must be designed according to TC10 reference circuit

INH behaves differently in two operating modes:

Status	INH behavior	Meaning
TC10 Sleep	Hi-Z	External pull-down causes LDO EN to be pulled low → power is disconnected
Non-TC10 mode	High level	LDO does not automatically turn off due to INH

Thus:

- An external 2–10k Ω pulldown resistor must be connected;
- INH directly drives LDO's EN (or drives it jointly with MCU via logic gates);
- Even if TC10 is disabled, INH will not accidentally trigger a power-off.

3.3 The WAKE pin must be integrated into the system power management

WAKE needs to meet the following design requirements during this sleep-wake process:

- Local key/MCU can pull WAKE high to trigger wake;
- A 10k Ω pull-down is needed to avoid false wake;
- In TC10 Sleep mode, WAKE can force PHY to trigger power-on.

Even in non-TC10 mode, it is often necessary to restore power through a WAKE signal and to maximize system power policy consistency. Therefore, it is recommended to always retain WAKE hardware.

4. The recommended unified hardware architecture is compatible with both TC10 and non-TC10 modes

4.1 Power structure

1. INH → LDO EN directly controls the main power switch
2. MCU GPIO can be OR/AND logic with INH:
 - Hardware OR: MCU can also force the system to power off (non-TC10 mode)
 - INH is still able to properly power down in TC10 Sleep
3. VSLEEP is always powered on

5. Recommended software control strategy

5.1 System behavior with TC10 enabled

- TC10 register is enabled
- Upon receiving LPS, the system can choose:
 - Agree → Enter TC10 Sleep → INH Hi-Z → LDO off → PHY power off
 - Reject → Turn off TC10 → PHY returns to Normal
- Remote wake (WUP) can be powered on automatically
- WAKE can be woken locally

Or follow the standardized TC10 process to draft.

5.2 System behavior to disable TC10

- No longer respond to TC10 protocol
- INH remains high at all times and power is not automatically cut off
- The system sleep mode can be customized, for example:
 - MCU pulls LDO EN low → PHY power off
 - Or enter low power through register BMCR.PD first

At this point, the system's main control logic determines when to power off.

6. Summary of differences in TC10 vs Non-TC10 Mode

6.1 Hardware differences

Design point	TC10 mode must	Whether it is required for non-TC10 mode	Design recommendations
VSLEEP power-on independently	Must	Recommendations	Always retain
INH controls LDO EN	Must	Not affect	Always retain
WAKE function	Must	Recommendations	Always retain
MCU drives LDO EN	Optional	Recommendations	OR or AND with INH
LDO/PMIC configuration for PHY	Standardized using TC10 architecture	Custom	Use TC10 architecture uniformly

6.2 Software differences

Functions	TC10 mode	Non-TC10 mode
Entry to sleep mechanism	TC10 state machine	System customization
Automatic switch-off	Yes (through INH)	No (MCU control required)
Wake Mechanism	WUP/WAKE pin	WAKE/system logic only
To match the capabilities of the pair end	Auto negotiation	TC10 is not supported

7. Final compatible design recommendations

To support various automotive network topologies and OEM power management strategies on the same ECU and PHY:

- The hardware is designed exactly as per TC10 recommended architecture (VSLEEP + INH + WAKE).
- Whether or not TC10 is enabled is software-determined.
- In non-TC10 mode, the system can still power off autonomously without any conflicts.

This ensures

- Full compatibility with TC10-enabled devices
- And devices that do not support TC10 can work reliably
- The system can still autonomously power off based on the whole vehicle power strategy
- No two-revision hardware design is required
- Minimized future adaptation risks

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Last updated 10/2025