

CAN FD

The complete migration guide for engineers and technical decision-makers

8x

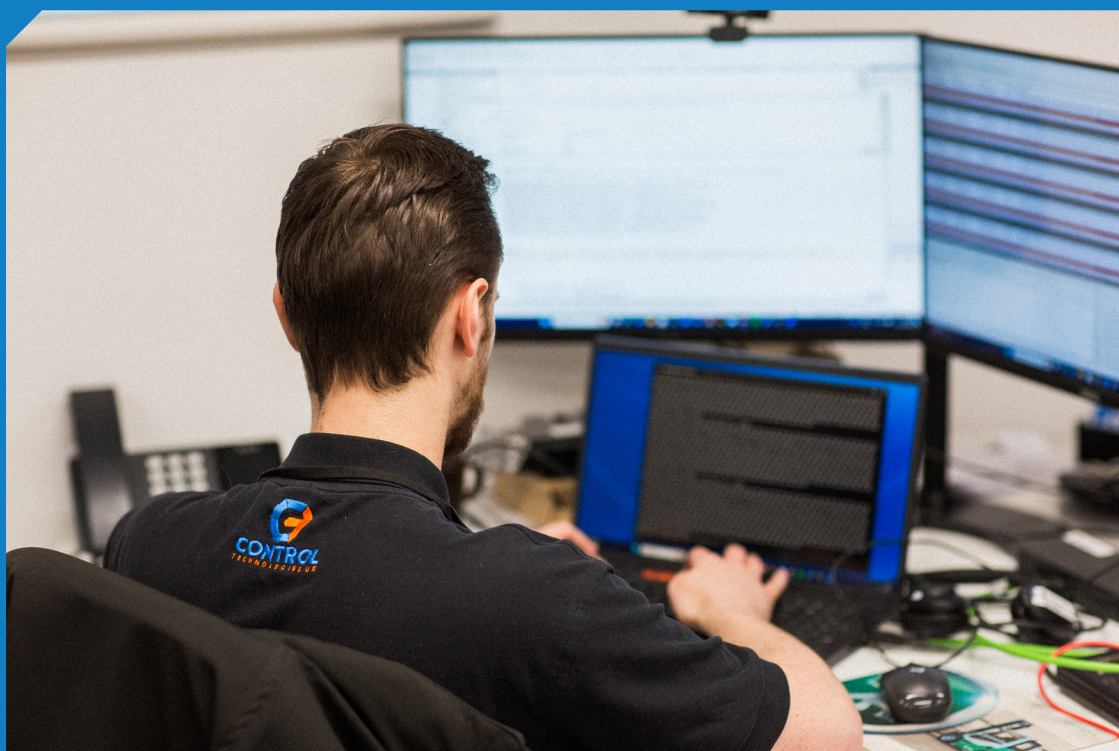
Higher data rate up to
8 Mbit/s vs 1 Mbit/s

64

Bytes per frame vs 8
bytes in Classic CAN

21-bit

Enhanced CRC vs 15-bit
in Classic CAN



In this Guide:

- What is CAN FD and why it was created
- Technical overview and how it works
- Why move to CAN FD
- Migrating to CAN FD
- How CT-UK can help
- Hardware guide by use case
- CAN FD FAQs for engineers
- Real-world case studies

What is CAN FD and Why Does It Exist?



Classic CAN transformed vehicle and machine electronics when Bosch introduced it in 1986. Robust, fault-tolerant, and deterministic, it became the backbone of embedded networks across automotive, agriculture, off-highway, and industrial sectors. But four decades of innovation have pushed it to its limits.

The Classic CAN Problem

Modern vehicles now carry 100+ ECUs. Precision agriculture systems generate continuous high-frequency sensor streams. ADAS and telematics demand data volumes that Classic CAN simply cannot support:

- Maximum 1 Mbit/s often 250 - 500 kbit/s in practice
- Maximum 8 bytes per frame
- Segmentation overhead for larger data transfers
- Bus load becomes a bottleneck as nodes increase

The CAN FD Solution

Developed by Bosch from 2011 and standardised as ISO 11898-1:2015, CAN FD keeps everything that makes CAN great and removes the ceiling:

- Same arbitration - fully compatible bus access
- Faster data phase - switches to up to 8 Mbit/s mid-frame
- 64-byte payload - 8x more data per frame
- Enhanced CRC - stronger data integrity for safety systems

Classic CAN vs CAN FD at a Glance

	Classic CAN	CAN FD
Max Bit Rate	1 Mbit/s	8 Mbit/s (data phase)
Max Payload	8 bytes	64 bytes
CRC Strength	15-bit	17 or 21-bit
Throughput Gain	Baseline	3–8x improvement
Backward Compatibility	—	Arbitration-phase compatible
ISO Standard	ISO 11898-1:2003	ISO 11898-1:2015

How CAN FD Works

CAN FD operates at two different bit rates within a single frame. The arbitration phase runs at the standard CAN rate. Once a node wins arbitration, the frame switches to the higher data-phase rate to transmit the payload, then switches back for end-of-frame signalling.

The FDF (FD Frame) bit identifies the frame as CAN FD, while the BRS (Bit Rate Switch) bit signals the transition to the faster data phase. Classic CAN nodes will generate an error if an FD frame is transmitted on the same bus, which is why mixed Classic CAN/CAN FD networks require gateway separation.

The Dual-Rate Frame

Arbitration Phase	BRS	Data Phase (fast)	CRC	EOF/ACK
≤1 Mbit/s		up to 8 Mbit/s up to 64 bytes		≤1 Mbit/s

Why This Matters in Practice

In Classic CAN, larger datasets must be split across multiple frames, increasing bus load, latency, and software complexity. CAN FD reduces this overhead by transmitting larger payloads at higher data rates within a single frame. The result is faster communication, improved network efficiency, and better support for modern applications such as ADAS, precision agriculture, industrial automation, and high-frequency sensor acquisition.

Key Technical Facts

Payload sizes (DLC mapping):
0-8 bytes 12-16-20-24-32-48-64

CRC protection:

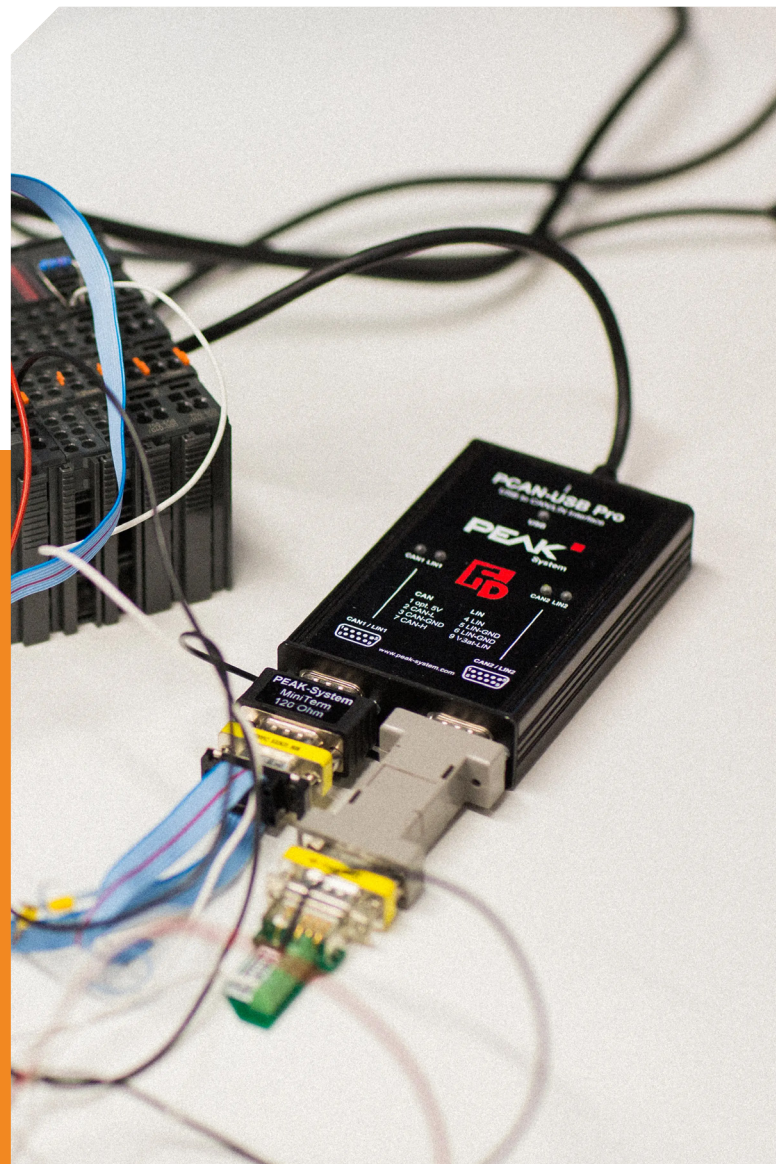
17-bit for ≤16-byte payloads 21-bit for 17-64-byte payloads

Cable length guidance:

2 Mbit/s ~12 m max
4 Mbit/s ~5-7 m max
8 Mbit/s ~2 m (board-level)

Standards:

ISO 11898-1:2015 CIA 601/602 SAE
J1939-22



Implementation Essentials



Hardware

CAN FD-capable transceiver (e.g. NXP TJA1462). Crystal oscillators recommended as ceramic resonators can fail above 1 Mbit/s.



Topology

Linear bus, split 120Ω termination. Stubs >0.3 m at 4 Mbit/s can cause signal reflections that corrupt frames.



Bit Timing

Configure separate Nominal and Data Bit Timing. Enable TDC (Transceiver Delay Compensation) at ≥2 Mbit/s.



Validation

Validate with a CAN FD protocol analyser. Where available, use oscilloscope-based eye diagram analysis to assess signal integrity.

Why Move to CAN FD?

Classic CAN has served embedded networks well for four decades. But bus load ceilings, 8-byte payload limits, and segmentation overhead are now a real constraint on what modern systems can do. CAN FD removes those ceilings without replacing the fundamentals that make CAN work.

Engineering Benefits



- 3–8x more bandwidth - more nodes, faster control loops, higher sensor rates
- Simpler software - 64-byte payloads eliminate segmentation complexity
- Faster FOTA/SOTA (firmware and software over-the-air updates) - significantly reduced update times due to higher throughput and larger payloads
- Supports safety-critical designs aligned with ISO 26262 / IEC 61508

Commercial Benefits



- OEM alignment - CAN FD now specified across automotive, agriculture, and off-highway platforms
- Future-proofed - CAN FD is the foundation for CAN XL
- Hardware costs are increasingly comparable, depending on component selection
- Competitive edge - CAN FD expertise differentiates in tenders and supplier qualification

Migrating to CAN FD:

What You Need & How to Do It

Migrating from Classic CAN to CAN FD doesn't have to be a big-bang replacement. Choose the approach that fits your platform lifecycle, then work through the four upgrade layers.

Migration Approaches

Most projects don't start with a blank sheet. Choose the architecture that fits where you are in your platform lifecycle. You can always move up the complexity ladder as confidence grows.

Approach	What changes	Best for	Complexity
CAN FD Island	High-bandwidth subsystem moves to CAN FD. Gateway bridges to Classic CAN backbone.	Adding CAN FD to an existing platform with minimal disruption	Low
CAN FD Backbone	Main backbone upgraded to CAN FD. Legacy subsystems connect via Classic CAN drops.	New platforms where the backbone can be freshly specified	Medium
Full Migration	All nodes move to CAN FD. Frames switch to FD progressively via firmware updates.	New-generation platforms with budget for full hardware refresh	High

What You Need to Upgrade

Every CAN FD migration touches the same four layers: physical, controller, software, and tooling. They're not independent; a correctly configured MCU won't save you from a bad transceiver choice, and the right hardware won't compensate for misconfigured bit timing.

Get all four right in sequence and the rest follows. The table below maps out exactly what needs to change at each layer.

Layer	What to replace / upgrade	Key requirement
Physical layer	CAN FD-capable transceivers (e.g. NXP TJA1462). Split 120Ω termination. Shorter stubs at high rates.	Crystal oscillators strongly recommended above 1 Mbit/s - ceramic resonators often introduce timing errors
Controller / MCU	STM32 (G4, H7), NXP S32K, Infineon AURIX all have native CAN FD peripherals. Legacy MCUs without CAN FD need replacement.	Separate nominal/data bit timing registers. TDC support required for ≥2 Mbit/s
Software / stack	Update CAN driver (AUTOSAR MCAL / LL). CANopen FD (CiA 602) or J1939-22 if used. DBC files need FD frame definitions.	Correct DLC mapping: 0-8, 12, 16, 20, 24, 32, 48, 64 bytes
Tools	PCAN-USB FD for bench bring-up; PCAN-USB Pro FD for dual-channel capture; PCAN-MiniDiag FD for field diagnostics.	Analyser must support CAN FD frame decoding. PCAN-Explorer 7 (PE7) is recommended for in-depth frame analysis and simulation.

Migration Checklist

Steps 1–3 are planning; 4–6 configuration; 7–9 validation and rollout. Most teams underestimate steps 4 and 5 - that's where configuration and integration issues typically arise, and where CT-UK adds the most value.

Steps

- | | |
|--|---|
| 01 Audit current network - node count, bus load %, latency requirements, harness lengths | 06 Update DBC files with CAN FD frame definitions and correct DLC mapping |
| 02 Choose architecture: Island / Backbone / Full | 07 Update software stack - CAN driver + CANopen FD / J1939-22 if applicable |
| 03 Select CAN FD hardware - confirm TDC support for target data rate | 08 Validate on bench with PCAN-USB FD - verify signal integrity before deployment |
| 04 Calculate bit timing - separate Nominal and Data Bit Timing | 09 Staged rollout - monitor bus load and error frames before full cutover |
| 05 Review physical layer - stubs <0.3 m at ≥4 Mbit/s, split termination | |

How CT-UK Can Help

CT-UK provides end-to-end CAN FD services across our three core competency areas. Whether you are designing a new CAN FD network, integrating CAN FD with existing Classic CAN systems, or upskilling your team, we have the expertise and tools to support you.

Vehicle Communications

- CAN FD network architecture & topology design
- Bit timing calculation & validation
- Protocol analysis with PEAK PCAN-USB FD
- CAN FD Classic CAN gateway design
- J1939-22 & CANopen FD system design

Embedded Machine Control

- CAN FD peripheral configuration (STM32, S32K, AURIX)
- CODESYS PLC CAN FD integration
- Custom firmware with CAN FD stacks
- Functional safety support (ISO 26262 / IEC 61508)

Digitalisation

- CAN FD data acquisition & IoT gateways
- Fleet monitoring & remote diagnostics
- Python tooling & data pipeline development
- HMI integration with CAN FD data sources

**Ready to start your
CAN FD journey?**

Contact CT-UK today for a no-obligation technical discussion

www.controltech.uk.com

Hardware Guide by Use Case

Below are CT-UK product recommendations for the most common scenarios we see across our customer base, from automotive validation benches to industrial control panels.

Automotive / ADAS / Telematics



High data rates, tight harness constraints, safety-critical. Typically 2–5 Mbit/s with AUTOSAR or J1939-22 stacks.

- **Analysers:** [PCAN-USB Pro FD](#) - dual-channel for simultaneous Tx/Rx capture
- **Data logging:** [Mobilizer Standard 800](#) - 8x CAN FD, 2x LIN, 1x Ethernet

Precision Agriculture / Off-Highway



Longer harness runs, EMC-heavy environments. Recommended 1-2 Mbit/s. CANopen FD or J1939-22.

- **Embedded control:** [CANtroll Industry FD Kit](#)
- **Sensor I/O:** [MU-Thermocouple1 CAN-FD](#)
- **Analysers:** [PCAN-USB FD](#)

Industrial Machine Control



Panel environments, motion control, safety-critical applications. 500 kbit/s–2 Mbit/s typical. CANopen FD CiA 402.

- **Embedded module:** [PCAN-MicroMod FD ECU](#) or [PCAN-MicroMod FD Analog](#)
- **All-in-one:** [CANtroll Industry FD Kit](#)

Gateways - Classic CAN to CAN FD



Bridge an FD subsystem to a Classic CAN backbone without replacing all nodes. Typically tens to hundreds of microseconds depending on configuration.

- > [PCAN-Router FD](#) - compact, scriptable; message filtering and translation
- > [PCAN-Router Pro FD](#) - multi-bus routing for backbone-level deployments
- > [PCAN-Ethernet Gateway FD DR](#) - CAN FD to Ethernet/IP for remote monitoring or FOTA

Data Acquisition & Multi-Protocol Logging



Capture CAN FD alongside LIN or Ethernet. Common in vehicle integration, test, and fleet telematics.

- > [CANnector S](#) / [CANnector L](#) - 4x CAN + 2-4x CAN FD + LIN + DIO
- > [CANnector SE](#) / [CANnector LE](#) - adds EtherCAT for mixed-protocol architectures
- > [Mobilizer Standard 800](#) - 8x CAN FD, 2x LIN, 1x Ethernet; ideal for vehicle integration, testing and data logging.

CAN FD FAQs for Engineers

Physical Layer

Q: Can I run CAN FD on my existing CAN wiring harness?

Often yes, but it depends on your target data rate. At 500 kbit/s data phase, existing harnesses usually work fine. At 2 Mbit/s and above, stub length becomes critical - stubs >0.3 m at 4 Mbit/s cause signal reflections that corrupt frames. Shorter harnesses with proper 120Ω split termination are essential at higher rates.

Q: Do I need a new transceiver?

The key question is whether your CAN interface supports CAN FD, not just Classic CAN.

If you're using a PC-based analyser or interface that is Classic CAN only, it won't decode CAN FD frames or operate at data-phase speeds. You'll need a CAN FD-capable interface such as the PCAN-USB FD or PCAN-USB Pro FD. At the hardware level, CAN FD-capable transceivers are now cost-comparable to Classic CAN equivalents, so there's no significant price barrier to upgrading.

Q: Why does the datasheet say 8 Mbit/s but most engineers only use 2–4 Mbit/s?

8 Mbit/s is achievable only on very short bus lengths, typically around 1–2 m depending on conditions. For most vehicle or machine harnesses (>1 m), 2–4 Mbit/s is the practical ceiling. Always validate with an eye diagram before committing to a rate.

Q: What termination scheme should I use?

Split termination: two 60Ω resistors in series with a 4.7 nF capacitor to ground at the midpoint, at each bus end. This gives better common-mode filtering than a single 120Ω resistor and is optimal at high data rates, though a standard single 120Ω terminator at each end will work in many installations.

Bit Timing

Q: What is the difference between Nominal Bit Timing and Data Bit Timing?

Nominal Bit Timing controls the arbitration phase (≤ 1 Mbit/s). Data Bit Timing controls the faster data phase. Configured independently in your MCU's CAN FD registers. A misconfigured data phase is the most common cause of CAN FD bus errors during bring-up.

Q: What is Transceiver Delay Compensation (TDC) and when do I need it?

TDC compensates for the signal propagation delay through the transceiver and back. At ≥ 2 Mbit/s, this delay represents a significant fraction of a bit period. Enable TDC and set the offset to your transceiver's loop delay (typically 100–200 ns). Failing to do this at 4+ Mbit/s produces intermittent CRC errors under load.

Q: My bit timing looks correct but I'm getting frequent error frames. What should I check?

In order: (1) Verify crystal oscillator – ceramic resonators drift too much above 1 Mbit/s. (2) Check TDC is enabled and offset is correct. (3) Inspect the physical bus with a CAN FD protocol analyser – look for ringing indicating a stub or impedance

mismatch. (4) Confirm both nodes use identical Data Bit Timing settings. (5) Check transceiver supply decoupling.

Protocol & Frames

Q: Can Classic CAN nodes and CAN FD nodes coexist on the same bus?

Classic CAN and CAN FD nodes can share a bus only if FD frames are not used. Once CAN FD frames are transmitted, Classic nodes will generate errors requiring network separation or a gateway. Use a CAN FD gateway, such as the PCAN-Router FD, to bridge between segments.

Q: What payload sizes can I use? I see values like 12 and 20 bytes listed.

CAN FD uses a non-linear DLC mapping above 8 bytes. Valid sizes are 0–8, then 12, 16, 20, 24, 32, 48, 64 bytes. There are no intermediate values – if you specify DLC 9, you get 12 bytes with unused bytes padded. Size your buffers accordingly.

Q: Does CAN FD support remote frames?

No. CAN FD does not support RTR frames. If your current design relies on remote frames for data polling, move to periodic transmission or event-driven messaging on the producer side.

Software & Tooling

Q: Do I need to update my DBC files for CAN FD?

Yes. DBC files need updating to define CAN FD frames with correct DLC and extended payload sizes. PCAN-Explorer 7 (PE7) with the CANdb add-in is ideal for this, supporting CAN FD frame definitions and the non-linear DLC mapping above DLC 8.

Q: What analyser should I use for CAN FD bring-up?

[PCAN-USB FD](#) for bench work handles all CAN FD data rates and works with [PCAN-Explorer 7](#) (PE7) for frame analysis, logging, and simulation. [PCAN-USB Pro FD](#) for gateway validation where you need to capture both bus sides simultaneously. [PCAN-MiniDiag FD](#) for field diagnostics without a PC.

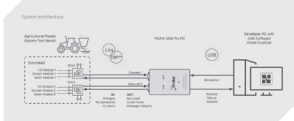
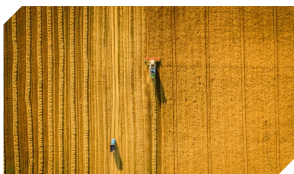
CAN FD Case Studies

Real-world implementations of CAN FD across automotive, motorsport, agriculture, and industrial applications. Case studies below are provided in partnership with PEAK System.

01 CASE STUDY

CAN FD Test Bench for Agricultural Machinery

Sector: Precision Agriculture / Off-Highway | **Partner:** PEAK System

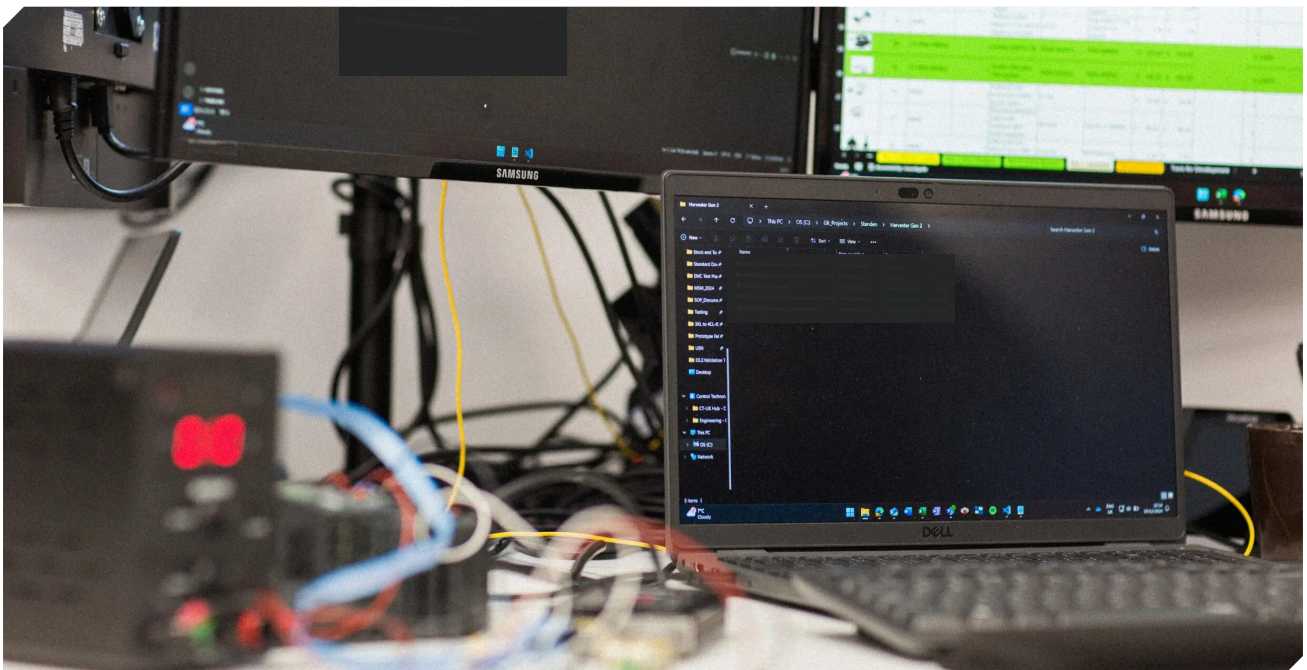


A next-generation agricultural planting system required a distributed CAN and CAN FD control architecture across multiple ECUs, sensors, and actuators. The challenge: validating complex communication, timing, and control logic before physical machines were assembled, avoiding the cost and risk of issues surfacing during late-stage integration or field testing.

CT-UK designed and built a laboratory-based CAN FD test bench using PEAK hardware and PCAN-Explorer 6, allowing the entire planter network to be simulated from a development PC. The setup provided real-time traffic monitoring, sensor signal injection, bus load analysis, and closed-loop interaction with control modules, all without requiring a fully assembled machine.

The result: early validation of the full CAN and CAN FD network, faster identification of communication and timing issues, and significantly shorter commissioning time once physical systems were built.

Read the full case study: <https://controltechuk.com/blog/case-study/can-fd-agricultural-test-bench/>



02 CASE STUDY

Flexible HiL Testing for Automotive Radar ECUs

Sector: Automotive / ADAS | **Partner:** PEAK System | **Country:** Germany



A leading German automotive supplier needed to test a new radar control unit for ADAS functions including adaptive cruise control and emergency braking — systems with the highest safety and reliability requirements. Previous HiL test benches were expensive, limited in availability, and difficult to adapt, creating bottlenecks that delayed development and constrained test coverage.

CT-UK's partner, PEAK, developed a hardware-in-the-loop system built around the PCAN-USB Pro FD, connecting radar ECUs directly to a test PC via USB. Test software running on Windows simulated typical driving manoeuvres — acceleration, braking, steering — transmitting signals to the control units via CAN FD. A DBC parser handled signal interpretation, while the PCAN-Basic API enabled automated test sequences in Python with real-time graphical visualisation.

The result: significantly expanded testing capacity at lower cost, shorter development cycles, and a scalable, future-proof validation environment now integral to the supplier's ADAS sign-off process.

Full case study: <https://www.peak-system.com/know-how/case-studies/hardware-in-the-loop-testing-for-radar-control-units/>

03 CASE STUDY

CAN FD Data Logging for Commercial Vehicle End-of-Line Testing

Sector: Commercial Vehicle / Automotive | **Partner:** PEAK System | **Country:** Germany



A leading European manufacturer of 40-tonne semi-trailer tractors required seamless data logging across multiple CAN and CAN FD buses during end-of-line testing of ECUs covering engine control, exhaust aftertreatment, transmission, and driver assistance systems. PC-based logging solutions were causing buffer overflows, data loss, and non-deterministic timestamping — making fault root cause analysis unreliable and requiring trained operator involvement for every test run.

The PCAN-Router Pro FD replaced the PC-based loggers as a standalone, autonomous data logger. Six CAN FD channels monitored the engine and chassis buses in parallel, storing data directly to 16 GB eMMC memory with microsecond-accurate timestamps from a battery-backed real-time clock. Automatic CAN-triggered start/stop eliminated the need for operator intervention, and freely programmable firmware filtered irrelevant frames during capture to reduce post-processing load.

The outcome: zero data loss in 24/7 operation, precise synchronisation between engine and transmission bus data, and a significant reduction in personnel costs and test bench interruptions.

Full case study: <https://www.peak-system.com/know-how/case-studies/multi-channel-logging-for-eol-test/>



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