K-Line: Flexible Solutions for a Classic protocol

From precise monitoring to data manipulation for generic byte protocols

In the past, the K-Line diagnostic protocol was the standard for diagnostic tasks in various vehicles, and it is still used widely used today. The age of this interface has not made it obsolete in today's diagnostics, development projects and service tasks for modern hardware and software. That is because it can be used to cover a wide range of requirements: from simple communication with the ECU to the support of proprietary K-Line variants on the byte level and finally simulations of entire K-Line diagnostic testers and K-Line ECUs.

The K-Line diagnostic protocol no longer plays a substantial role in new developments, because systems such as CAN and Ethernet have long taken over diagnostic tasks once performed by the K-Line. Nonetheless, automotive OEMs, suppliers and service shops worldwide cannot overlook the fact that many vehicles and ECUs still use K-Line technology, and this will remain the situation for some time. ECUs with a K-Line interface are still used in passenger cars, the truck sector and in motorcycles.

Those Presumed Dead Live Longer

Millions of passenger cars and motorcycles with K-Line technology are still driving on the roads, especially in markets such as China, India and South Asia. They are generally vehicles whose level of technology is outdated by around 10 to 15 years. Many European vehicle developments of that time were and are still being built in

Asia under license, although their production ceased many years ago here. It is still the usual practice – especially in cases of smaller production volumes – to continue to use proven ECU developments in subsequent or related product lines, and this too has extended the life of the K-Line.

Serial UART Diagnostic Protocol with Bus Characteristic

The K-Line is a diagnostic protocol that conforms to the ISO 14230 standard. Like the standard RS232 serial interface, it is based on the technology of typical UART (Universal Asynchronous Receiver Transmitter) circuits. In asynchronous transmission, the sender and receiver use start and stop bits for synchronization purposes. This means that the system does not need a supplemental clock line, and a single-wire line suffices. In contrast to RS232, the K-Line – like a bus system – enables communication with different

ECUs by addressing them. The standard transmission rate is 10,400 baud, and speeds up to 115.2 kbaud are used for such purposes as programming of flash memories.

The K-Line is suitable for both on-board and off-board diagnostics, and it offers two special initialization patterns: Fast-Init is based on a 10,400 baud standard, and it sends a wake-up pattern. There is also what is known as the 5-Baud Init pattern, in which the system sends an address byte at five baud, and the receiver detects this slow transmission rate. Also characteristic of the K-Line are special Key Bytes that are used to identify header formats and timing parameters.

One important task of automotive OEMs in the after-sales market is to support the service of all K-Line vehicles worldwide by providing service shops with suitable K-Line testers. In ECU development with K-Line, new functions are provided that need to be tested. Therefore, manufacturers and suppliers need powerful hardware and software tools that support the K-Line protocol for K-Line test equipment and ECUs.

More Stringent Requirements for Test Hardware

A basic prerequisite for any diagnostic or test process is a suitable interface hardware, which produces the connection between the diagnostic PC and the device under test. It is possible to use a PC's conventional UART/RS232 interface to test K-Line devices, but this method quickly encounters limitations. It lacks the advanced properties that are needed to check for conformity and to verify correct functionality. This also requires knowledge of how close the DUT is to operating at its specified limits, or expressed differently, the size of its functional reserves.

In contrast to RS232 solutions, efficient K-Line interfaces enable precise acquisition of communication timing. Both sent and received K-Line frames are provided with exact time stamps. They also offer automatic detection of baud rates – including fast initializations and 5-baud initializations – and it is also possible to manipulate K-Line timing and data and to send raw byte streams. These interfaces can be connected to any PC via USB, and they work together with software tools ideally, e.g. over a specialized K-Line API, which enables easy access to all hardware functions in test scripts.

Scalable K-Line Solutions

Vector offers a product line-up of K-Line components that are tuned to one another for the purpose of testing and simulating K-Line-developments; these components consist of high-quality interface hardware and high-performance software tools. The solutions cover all conceivable requirements and are flexibly scalable – from a single-channel K-Line monitoring tool to solutions that enable simulation of K-Line diagnostic testers and ECUs, and

finally large HIL systems. The latter are characterized by such aspects as real-time properties, and they can simulate multi-channel ECU environments for test runs, in which other bus systems such as CAN, LIN and FlexRay can be integrated along with K-Line. Vector can supply various types of interfaces for connecting to K-Line – via a USB interface or PCI bus. They include the VN1600 and VN8900 interface products as well as plug-in cards such as the VN7570 and the VT6204 for the VT System **(Figure 1)**. The 7269 LIN transceiver, which offers optimal K-Line support, handles transmission on the physical level.

Figure 1:
Different K-Line interfaces: from single-channel USB interface to HiL module

Support of Proprietary K-Line Variants and Byte Protocols

CANoe and CANalyzer are two alternative software tools that are available from Vector. While CANoe represents the universal solution for (automated) tests and simulations, the focus of CANalyzer is on analysis and monitoring tasks **(Figure 2)**. These tools permit access to all K-Line parameters and settings. Testing personnel can conduct the tests, measurements and injection of errors on different levels: on the diagnostic and communication levels and – a unique capability – on the byte level. This makes the tools usable for proprietary K-Line variants that deviate from the standard as well as generic serial byte protocols. Trace and analysis windows display timing, baud rates, header bytes, useful data, inter-byte and inter-frame spaces with high precision **(Figure 3)**. Other windows permit interactive sending of K-Line frames. The application programming language, CAPL, can be used to send raw frames and inject errors. Simulations can also be created with CAPL in conjunction with a special K-Line API. Test modules then produce the automatic test sequences and generate reports.

Figure 2:
K-Line test and simu-
lation environment

Figure 3:
K-Line analysis on different communication levels
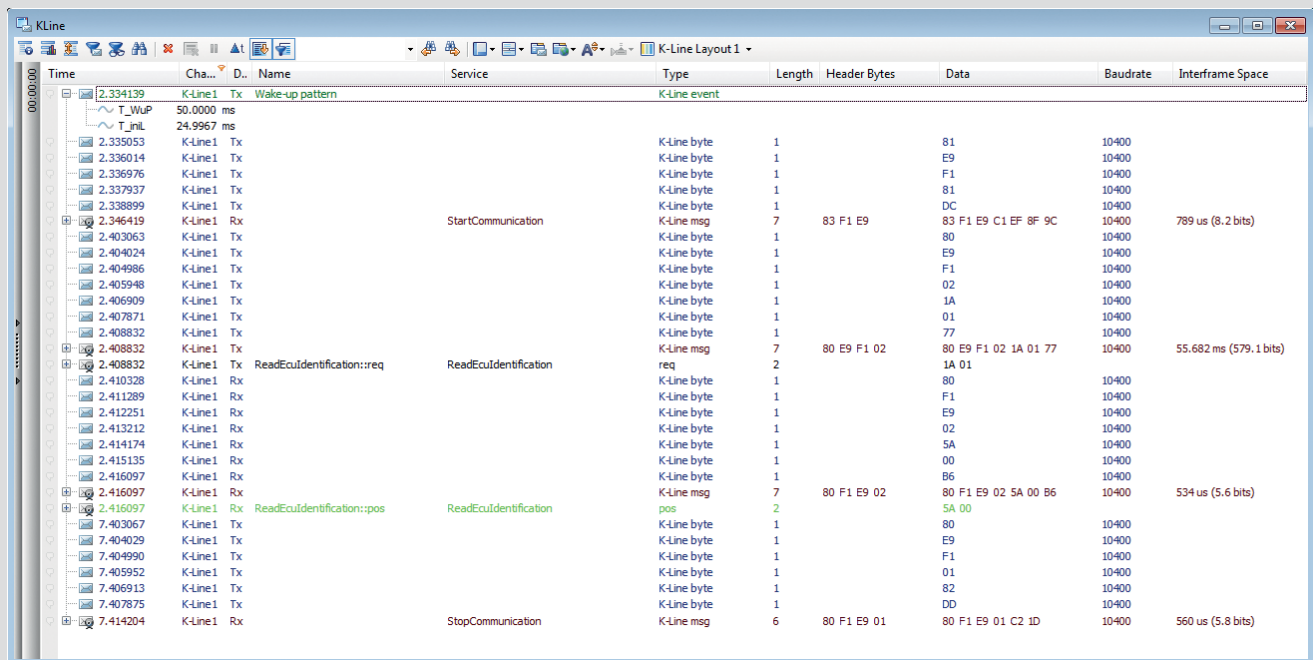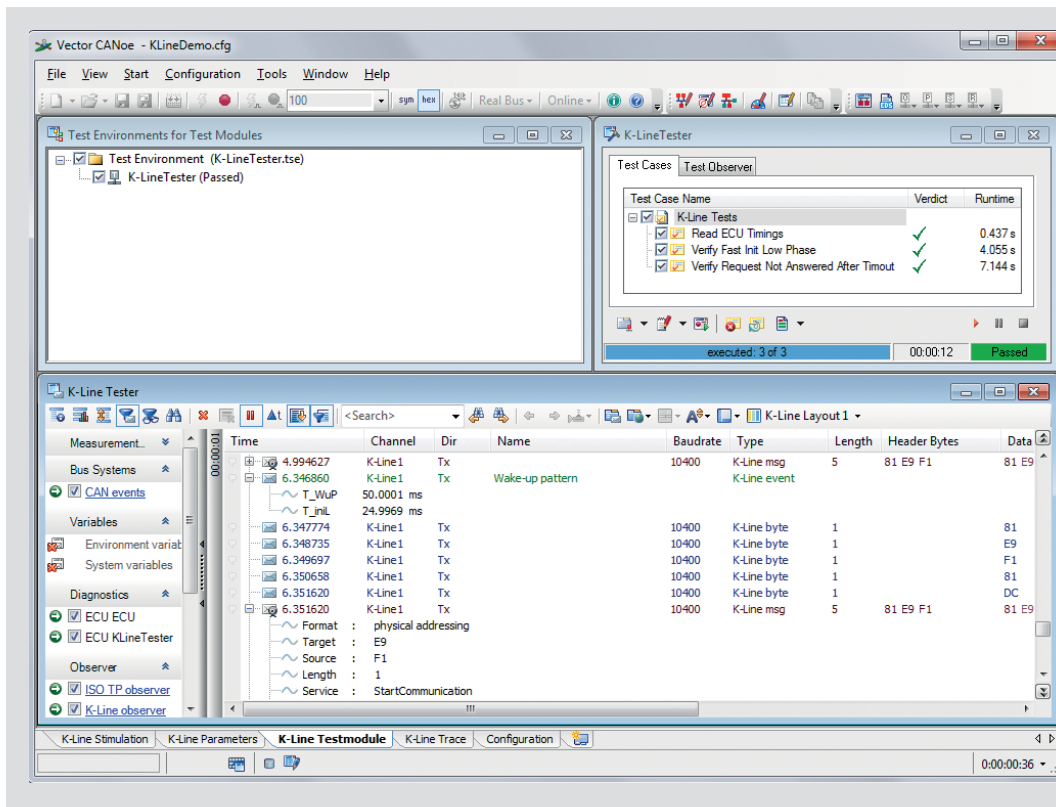
Summary

High-performance and modern tools are also available for the K-Line protocol, which has certainly aged over the years, but is still used for such purposes as maintenance of diagnostic testers and ECUs. They not only give automotive OEMs and suppliers qualified tests at a high level of quality; they also enable troublefree advanced development and reuse of existing K-Line components.

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